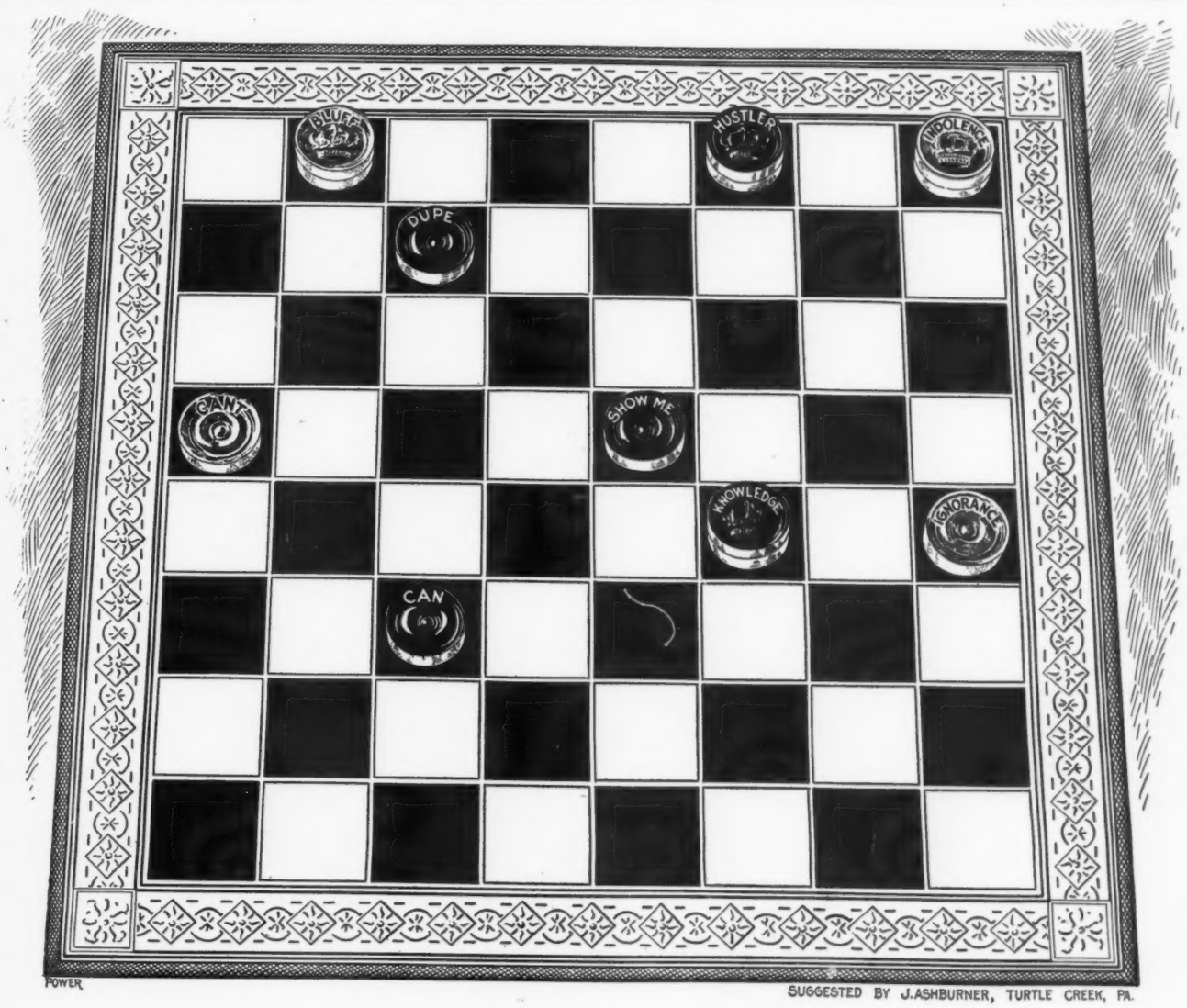
POWER

Vol. 40 NEW YORK, JULY 7, 1914. No. 1



SUGGESTED BY J.ASHBURNER, TURTLE CREEK, PA.

Playing the Game

DID you ever play a game of checkers? If so, you can see the points intended to be brought out in the cartoon. Every engineer is playing a game every day of his life. If he knows his job he can corner the other fellow every time. Examine the board and see what characteristics win out. King Bluff is in his own king row. He is in a position to jump the misled superintendent, or Man Dupe, and it is King Bluff's move. He jumps Man Dupe and gets in the way of Man Show me, and is immediately put out of business.

King Indolence has also got into his own king row and it is his move. When he does move King Hustler puts him out of the game. Man Can't is cornered by Man Can and Man Ignorance is sewed up tight by King Knowledge.

Moral: The best man always wins.

Staley Power Plant in Decatur

By Thomas Wilson

SYNOPSIS—This boiler plant is producing steam for 10.6c. per 1000 lb. A change from manual to automatic operation in handling the coal and ashes has reduced the boiler-room labor bill two-thirds, saving $43 per day.

In Decatur, Ill., the A. E. Staley Manufacturing Co. has a large plant for making starch of all varieties and other byproducts of corn. At the present rate of working, a maximum of about 800 kw. for power and lighting is required. There is a total of 90,000 lin.ft. of 1-in. pipe which must be supplied with exhaust and live steam to heat 300,000 cu.ft. of air per min. blown over the starch to dry it. Besides, steam for industrial purposes is in considerable demand; in fact, the load on the boilers is about equally divided between the engine room and the manufacturing plant.

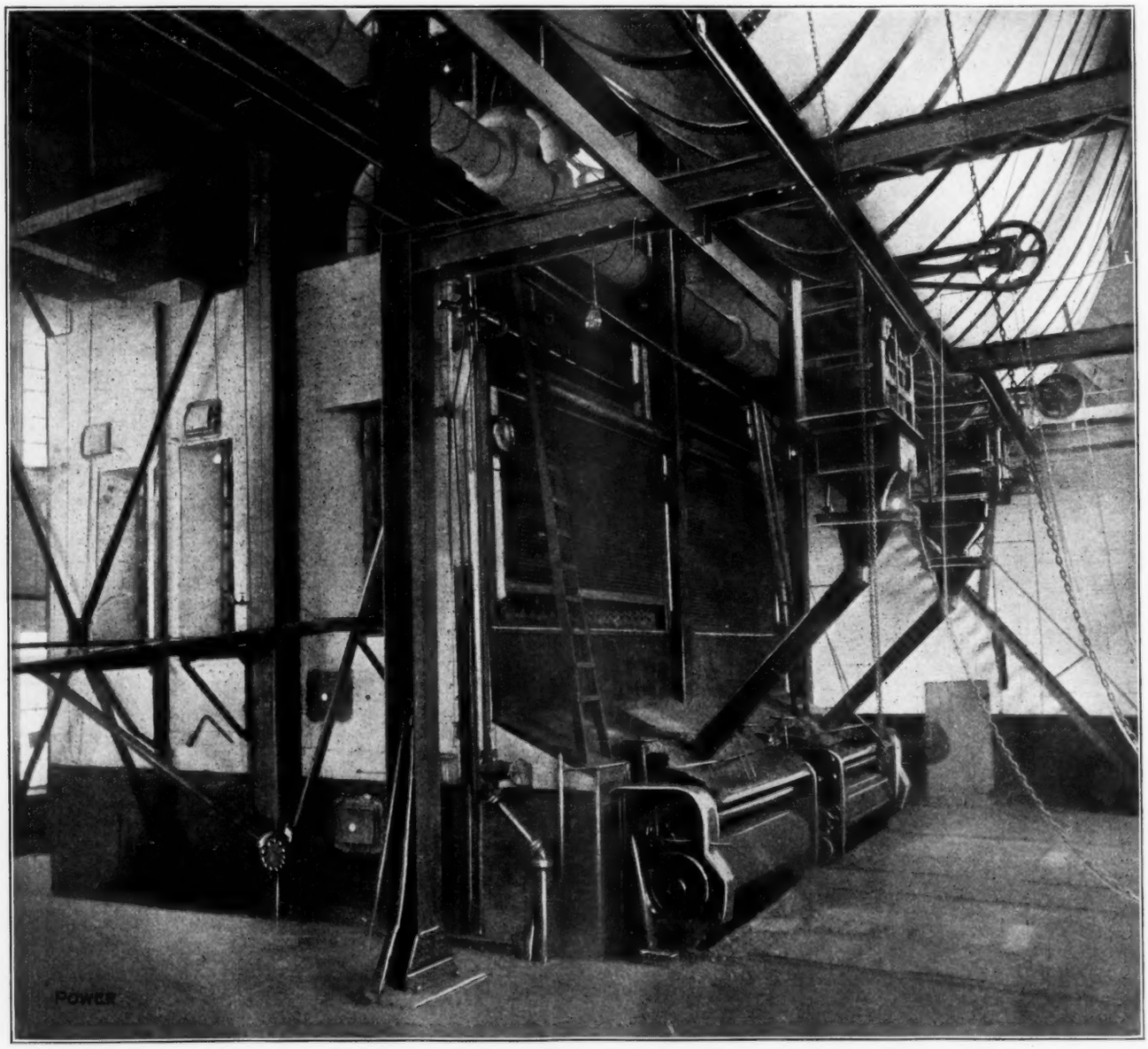


Fig. 1. Two of the Boiler Units, Showing Bunker and Coal Scales

The Boiler Plant

To supply this steam, four 550-hp. water-tube boilers have been installed, and, although only three, under damper control, are required to carry the load at present, it is expected that the demand for steam will increase sufficiently to warrant the two more boilers of the same size which will soon be installed.

Each boiler has 5500 sq.ft. of heating surface and is equipped with a chain-grate stoker having 100 sq.ft. of effective grate area. The ratio of heating to grate surface is 55 to 1, and may be counted low when it is considered

that the settings have been designed for normal loads of 200 per cent. of the builders' rating of the boilers. The air surface in the grates amounts to 35 per cent. and, because of the diagonal slots in the sides of the link, which are reversed in direction in the opposing link, this proportion is maintained without allowing a large percentage of the fine coal to drop through to the ashpit.

Furnace Design

As will be apparent in Fig. 2, giving a sectional view of one of the boilers, the furnace and setting have special features worthy of attention. The long ignition arch, together with the corbeling forward of the bridge-wall, results in a contracted opening through which the gases

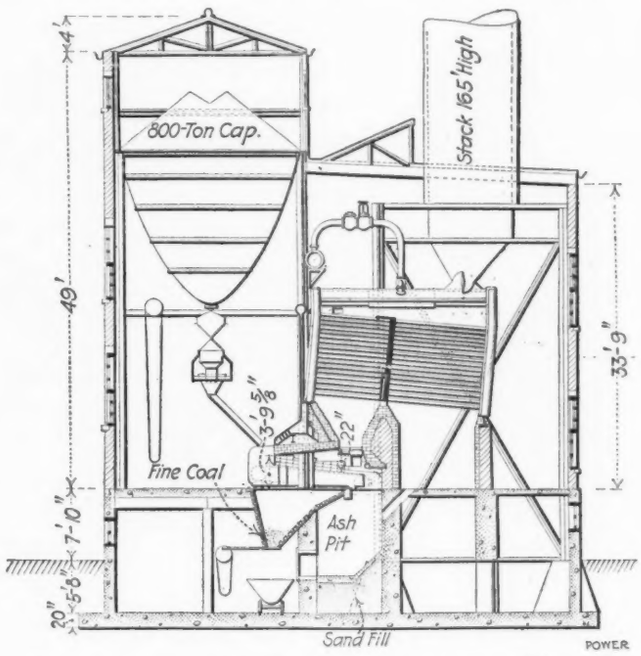


Fig. 2. Sectional View of One of the Boilers

must pass at right angles to their previous flow, the intention being to produce the sudden and thorough mixing necessary for the best combustion. The bottom of the tube header is 9 ft. 6 in. above the boiler-room floor and the stoker is set well under the boiler, so that there is little furnace extension. This arrangement gives a combustion space formed by a horizontal chamber underneath the long arch and a vertical chamber immediately under the first pass of the boiler; therefore, it is claimed that a strong igniting effect is secured near the feed gate where the fuel is first introduced to the furnace. As a consequence, the entire fuel bed is active and ready to respond to any increase in draft over the fire. In this particular plant there are frequent calls for large quantities of steam, and it was this condition which influenced the design of the furnace to a great extent.

At the rear end of the grate, underneath the opening between the arch and the bridge-wall, the combustion is intense, due to the draft available at this point, the thorough mixing of the gases and the strong ignition previously referred to. This capacity to meet sudden fluctuations in load and at the same time maintain the fires in uniform condition is in part responsible for the excellent records given on the next page.

Draft

The boilers are of the three-pass type, arranged two per battery, each pair having a common steel stack rising 200 ft. above the grates. This stack is 10 ft. in diameter and has a 6-in. lining of four-cell, radial tile which reduces the bore to 9 ft. The draft on the stack side of the damper is 1.3 in. of water, and over the fire is maintained by the damper at 0.4 to 0.6 in., although it can be run up to 1 in. if required.

The uptake at the boilers is rectangular, measuring 11 ft. 5½ in. by 2 ft. 4 in., and gradually rounds to the internal diameter of the stack. There is but little obstruction to the flow of gases. In a sense, there is no breeching. The flow of the gases from the boiler is upward directly into the stack. Two right-angle turns are avoided, also the interference of the gases of one boiler with those of another, and the friction of a long run of breeching. To secure these benefits, three stacks instead of one are necessary, but it was considered that the additional cost was warranted as it gave a natural-draft plant with nearly as great a range as would ordinarily be obtained with a forced-draft outfit.

Fine-Coal Hopper

Another feature, shown in Figs. 2 and 3, is the fine-coal hopper under each stoker, arranged so that it will

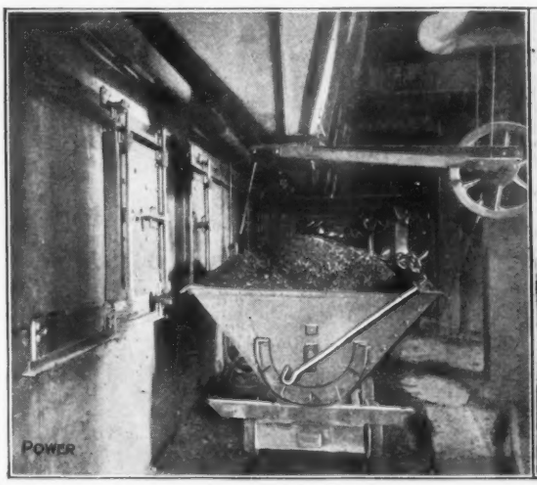


Fig. 3. Ash Cars and Fine-Coal Hopper Above

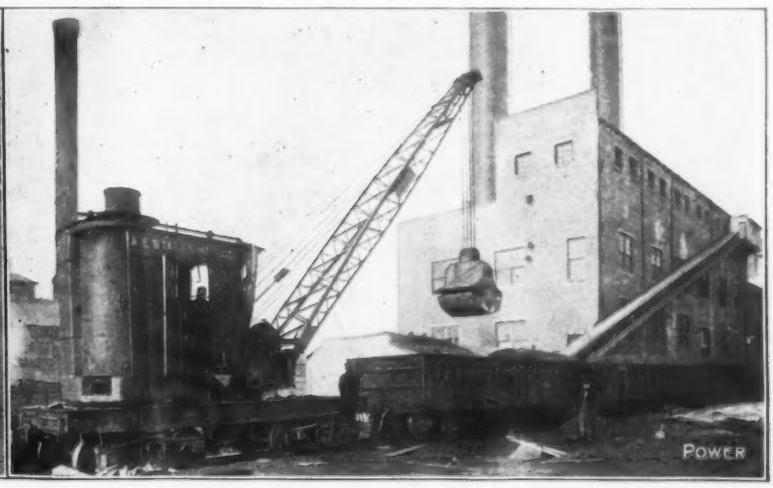


Fig. 4. Locomotive Crane and Inclined Belt Conveyor at Side of Boiler Room

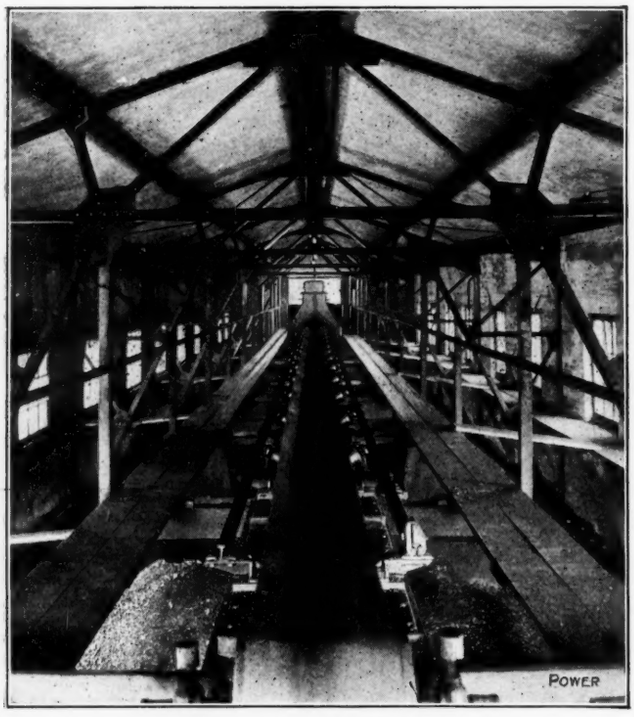


FIG. 5. CONVEYING BELT OVER BUNKER

rear of the grate is not conducive to good combustion or operation at high capacity; hence the desirability of excluding the air.

PRODUCING STEAM FOR 10.6C. PER 1000 LB.

Unwashed Springfield screenings, 1¼ in., is the fuel used, and in average daily operation from 42 to 45 lb. are burned per square foot of grate. This rate of combustion is obtained with a draft of 0.4 to 0.6 in. over the fire, carrying a 9-in. fuel bed, and if the maximum draft which the stack could produce were used, the rate would be still higher. Per pound of coal as fired, the evaporation from and at 212 deg. F. ranges between 7 and 8 lb., but it must be remembered that this is obtained with dirty coal, not exceeding 10,000 B.t.u., which costs $1.40 per ton delivered to the bunkers.

The data given in Table 1 for the week of Feb. 9 to 14 show what the plant is doing. No attempt was made to select favorable data; a week's record was picked out at random, so that the results should represent the average performance. It will be noticed that three boilers were run at 145 to 181 per cent. of the builder's rating 24 hr. per day. The cost for coal and labor per thousand pounds of steam runs as low as 10.6c. When it is considered that the usual cost for the same output averages from 15 to 20c., it will be appreciated that remarkable

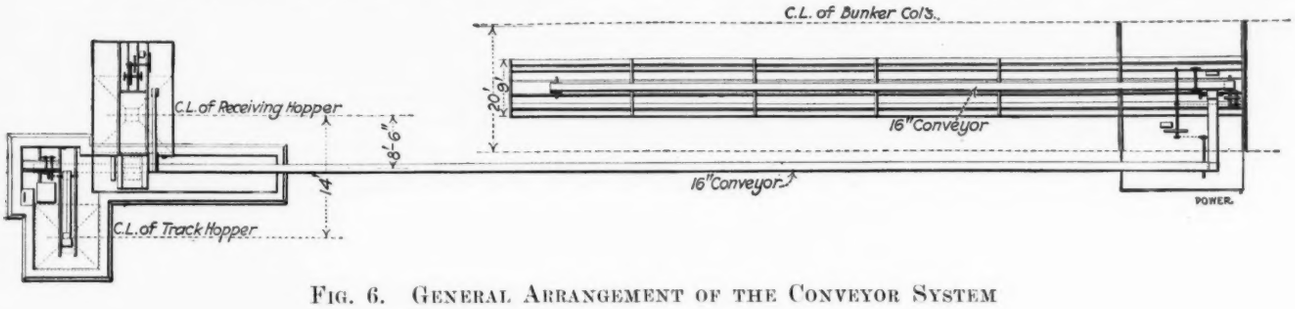


FIG. 6. GENERAL ARRANGEMENT OF THE CONVEYOR SYSTEM

TABLE 1. COST OF STEAM AT THE STALEY PLANT

	Monday Feb. 9, 1914		Tuesday Feb. 10, 1914		Wednesday Feb. 11, 1914		Thursday Feb. 12, 1914		Friday Feb. 13, 1914		Saturday Feb. 14, 1914	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Duration of run, hr.	11	13	11	13	11	13	11	13	11	13	11	13
Boiler pressure, lb. gage	142	142	142	142	142	142	142	142	142	142	142	142
Feed-water temp., deg. F.	200	200	200	200	200	200	200	200	200	200	200	200
Evaporation factor	1.057	1.057	1.057	1.057	1.057	1.057	1.057	1.057	1.057	1.057	1.057	1.057
Total water evaporated, lb.	1,071,204	1,198,296	935,034	1,161,984	1,008,580	1,098,438	1,034,892	1,181,957	1,080,282	1,229,161	925,056	1,014,920
Total equiv. evap. f. and a. 212 deg. F.	1,132,262	1,266,598	988,331	1,228,217	1,066,069	1,161,058	1,093,880	1,249,328	1,141,858	1,299,223	977,784	1,072,770
Water evap. f. and a. 212 deg. per hr.	102,933	97,431	89,849	94,478	96,915	89,312	99,443	96,102	103,805	99,940	88,889	82,521
Evap. f. and a. 212 deg. per lb. coal as fired, lb.	8.09	7.63	6.59	7.22	7.5	7	7.6	7.1	8.27	8.02	6.88	6.62
Boiler hp. developed	2983	2824	2602	2738	2809	2588	2882	2786	3008	2897	25.77	2390
Per cent. of builders rated hp.	181	171	158	166	170	157	175	169	182	176	156	145
Weight of coal as fired, tons	70	83	75	85	71	85	72	88	69	81	71	81
Grate surface in use, sq.ft.	300	300	300	300	300	300	300	300	300	300	300	300
Coal burned per sq.ft. of grate per hr., lb.	42.4	42.5	45.4	43.6	43	43.6	43.6	45.2	41.8	41.5	43	41.5
Cost of coal, dollars	98	116.20	105	119	99.40	119	100.80	123.20	96.60	113.40	99.40	113.40
Cost of fireman, assistant, 4 laborers, dollars	21.20	17.65	20.20	20.05	22.02	24.30	20.85	21.42	21.52	19.70	22.02	20.05
Total fuel and labor cost, dollars	119.20	133.85	125.20	139.05	121.42	143.30	121.65	144.62	118.12	133.10	121.42	133.45
Cost of 1000 lb. steam f. and a. 212 deg. F., dollars	0.106	0.106	0.127	0.113	0.113	0.123	0.111	0.116	0.103	0.103	0.124	0.125

deliver the coal to the same cars which receive the ashes; the coal is returned to the conveyor system. The ash cars are of steel and side-tilting; the car body is detachable so that it can be picked up by a crane and the contents dumped into a railway car. The ash hopper is reinforced concrete. The doors are lined with firebrick, mounted on rollers, and, as may be seen in Fig. 3, are specially equipped with a system of levers by which they can be made air-tight. Leakage of cold air around the results are being obtained. When the plant is extended and the load increased so that the boilers may be run at fully 200 per cent. of rating without any appreciable increase in labor, the above costs may be slightly lowered.

Burning the lowest-priced coal on the Decatur market under excellent conditions for good combustion, and an efficient coal-handling system reducing the labor in the boiler room to a minimum, are the factors responsible for the low cost of steam.

To be consistent, a conveying belt system transfers the coal in the railway car to the stokers at a cost ranging from 2 to 3c. per ton. The system has a capacity of 50 tons per hour, a bunker storage of 800 tons and between the bunker and hopper of each stoker a Richardson scale intervenes, so that the weight of fuel to the furnaces may be recorded as it is used. A 10-hp. motor moving 680 ft. of belt is the power required for transferring the coal. The general arrangement of the system is shown in Fig. 6. Fine coal is discharged from bottom-dump cars into a 10x10-ft. track hopper to the bottom of which are attached skirt boards for guiding the coal onto a short

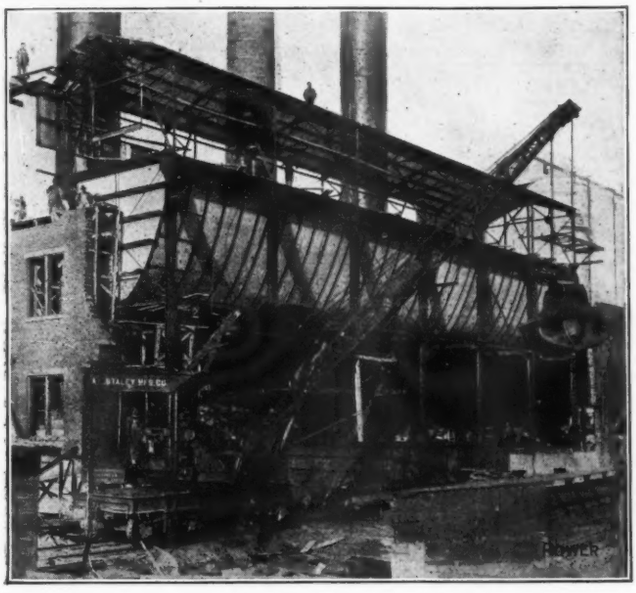


FIG. 7. FERRO-INCLAVE BUNKER UNDER ERECTION

cross-belt delivering to a 16-in. inclined belt running along the side of the boiler room, as in Fig. 4. At the point of feed, a slide gate is provided which may be regulated from the ground level. Run-of-mine coal is discharged into a 12x12-ft. receiving hopper by a locomotive crane which also handles the coal to and from the outside storage. From the hopper the coal passes to a shaking feeder given a reciprocating motion by a pair of connecting rods through crank disks and a direct gear drive to a 3-hp. motor. The shaker feeds the coal to a two-roll crusher (rolls, 20 in. in diameter, with 30-in. face) at a uniform rate of 50 tons an hour. From the crusher, which is driven by a 20-hp. motor, the coal is delivered to the inclined conveyor. A bypass chute around the crusher handles the fine coal.

All of the conveyors are designed for a speed of 250 ft. per min. From the receiving hoppers to the upper end of the incline is approximately 184 ft., and the rise about 40 ft. above the ground level. A short cross belt transfers the coal to the delivery belt running over the bunker in a reverse direction and parallel to the inclined belt. The conveyor over the bunker has an automatic self-reversing-and-propelling tripper with 90 ft. of track; this appears in the background of Fig. 5. An elevator at the near end of the boiler room would have shortened the coal travel, but it would have necessitated more power per ton of coal delivered. As it is, a 10-hp. motor, by means of the transmission mechanism indicated in Fig. 6, drives the four conveyor belts.

Fig. 7 shows the coal bunker under erection. This is made of steel and concreted on both sides; the method of support is indicated. The shape of the bunker insures delivery of most of the coal to the hoppers of the automatic scales, which weigh 100 lb. at a time. The scales are mounted on a structural-steel carriage carried by wheels on a channel iron runway. A motor operates the shaking feeder of the scale, and the gates admitting the coal from the bunker are controlled by a chain reaching to the floor.

SAVING $43 PER DAY IN LABOR

Before the new boiler plant was installed, the company had in its plant three 235-hp. and one 280-hp. water-tube boilers equipped with shaking grates. The coal was unloaded and fired by hand and the firemen were worked on three 8-hr. shifts. Thirty-seven men were employed at a cost of $63.60 per day of 24 hr.

When the new plant was installed and equipped with stokers and the coal- and ash-handling systems, the number of men was reduced to 10, the time to two 12-hr. shifts and the cost of unloading the coal from 6 to 7c. per ton to a figure averaging from 2 to 3c. The number of men, the duties of each and their wage are given in Table 2.

THE ENGINE ROOM

In the engine room, Fig. 8, part of the old equipment is still retained. This consists principally of a 550-kw. generator driven through a rope by a 24x42-in. Corliss engine, a 1000-kw., single-stage, noncondensing turbo-unit and a 100-kw., direct-connected engine-driven unit. Each generates three-phase current at 440 volts, used direct by the motors and transformed to 110 for lighting.

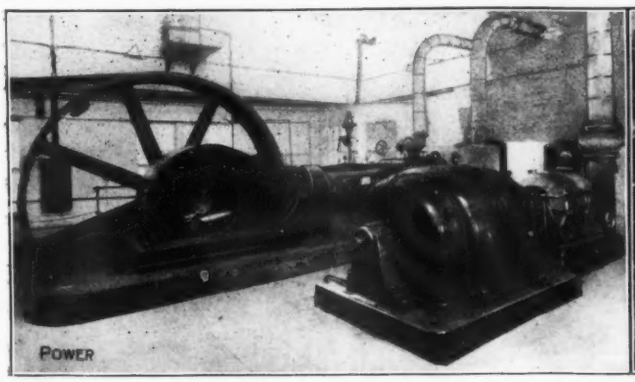


FIG. 8. TURBINE AND CORLISS ENGINE UNITS

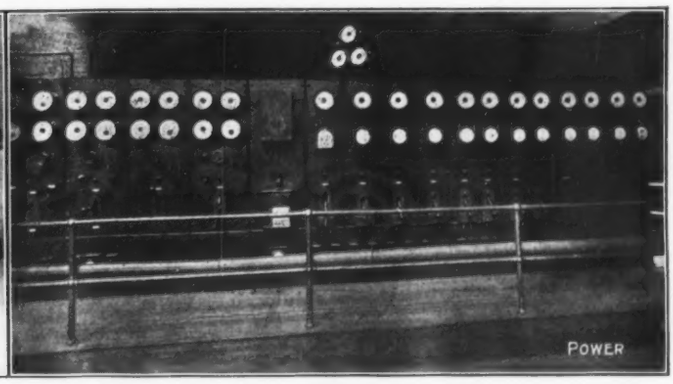


FIG. 9. VIEW OF THE NEW SWITCHBOARD

The initial steam pressure to these machines averages 150 lb. gage and the back pressure 2½ lb. A steam-flow meter has just been installed to measure the steam to the engine

TABLE 2. LABOR DISTRIBUTION IN BOILER ROOM

Old Method	
3 Firemen, three 8-hr. shifts at 25c	$18.00
2 Fire pullers, three 8-hr. shifts at 25c	12.00
2 Coal passers, two 12-hr. shifts at 17½c	8.40
4 Unloading coal, three 8-hr. shifts at 17½c	16.80
2 Ash wheelers, three 8-hr. shifts at 17½c	8.40
	$63.60
Average cost of unloading coal per ton (including unloaders and coal passers)	$0.06 to 0.07
New Method	
1 Fireman, two 12-hr. shifts at 20c	$4.80
1 Helper, two 12-hr. shifts at 17½c	4.20
2 Ashmen, two 12-hr. shifts at 17½c	8.40
2 Men unloading coal 10-hr. at 17½c	3.50
Total	$20.90
Average cost of handling coal per ton	$0.02 to 0.03

room, and it is intended to have others, so that each department may be credited with its proper consumption.

A Model Switchboard

On the electrical end the same plan has already been adopted. There is a meter for every department. The switchboard, Fig. 9, is the feature of the engine room and gives some indication of what this part of the power plant will be when completely remodeled. Both the board and the instruments have been painted black, and with bright metal trimmings the appearance is neat and attractive. There is a full assortment of Westinghouse instruments. Midway between the back of the board and the wall are the hand-operated oil switches. The operating levers and the cables run under the floor and up through pipes to the switches; the outgoing cables are also run under the floor to the wall and are inclosed in pipes. Thus the space back of the board is unusually clear and, contrary to usual practice, presents an orderly appearance.

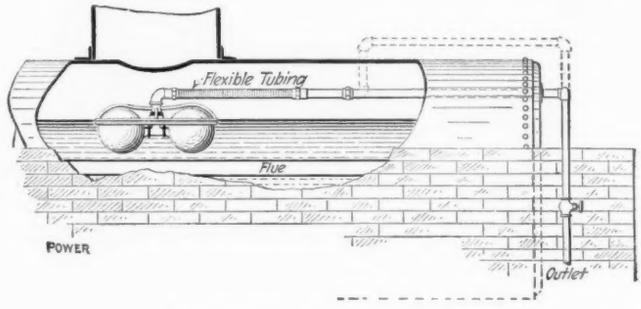
An innovation in switchboard lighting has been introduced. A row of incandescent footlights, mounted in a long reflector secured to the railing, shine upward on the instruments, and a similar row shine down from a canopy over the board. With this arrangement there is no shadow on the face of the meters, and a reading may be taken accurately from any position.

To G. E. Chamberlain, superintendent of the company, belongs the credit for the layout of the new power plant and for many labor-saving devices in manufacturing the different products.

Schreiber Boiler Skimmer

A device known as the Schreiber boiler skimmer, for removing scum in steam boilers, is illustrated herewith. It can be placed in any type of boiler.

As shown, the skimmer consists of two copper seamless floats, around which, just above the center line, is a hollow band slotted on the outside. There are four copper discharge pipes secured to the upper side of the band at one end and to the main discharge pipe at the other. The main discharge pipe is flexible copper tubing, which allows the skimmer to rise and fall with the water level in the boiler.



Schreiber Boiler Skimmer

Owing to the shape of the skimmer, floating particles are drawn into the slot from all sides when the blowoff valve is opened. The outlet can be carried through the rear of the boiler or out through the top, as shown by the dotted lines. The skimmer is manufactured by the Lincoln Boiler Cleaner Co., Lincoln, Ill.

TABLE 3. PRINCIPAL EQUIPMENT OF STALEY POWER PLANT, DECATUR, ILL.

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
4	Boilers	Water-tube	550 hp.	Steam generators	150 lb. gage, mechanical stokers	Edge Moor Iron Co.
4	Stokers	Chain grate	100 sq.ft.	Boiler furnace	Mechanical	Laclede-Christy Clay Prod. Co.
2	Stacks	Steel, 6-in. lining	200x10 ft.	Furnace gas	Draft stack 1.3 in., over fire 0.4 to 0.6 in.	Hammler, Boiler & Tank Co.
1	Bunker	Ferroinclave	800 tons	Coal storage		Brown Hoisting Machinery Co.
1	Conveyor system	Belt	50 tons per hr.	Coal car to bunker	250 ft. per min.	Robins Conveying Belt Co.
4	Ash hoppers	Reinforced concrete		Ash from boiler furnace		Brown Hoisting Machinery Co.
1	Ash cars	Steel side tilt		Ash from hopper to dump		Brown Hoisting Machinery Co.
1	Crane	Locomotive	15 tons	Handling coal and ash	125 lb. gage	Brown Hoisting Machinery Co.
1	Feed water-heater	Open	3000 hp.		Exhaust steam	Harrison Safety Boiler Works
4	Scales	Automatic	100 lb. per weighing	Coal for boilers	Weigh as coal is fed to stoker	Richardson Scale Co.
2	Pumps	Single	12x7x12 in.	Boiler feed	150 lb. steam pressure	American Steam Pump Co.
4	Pumps	Duplex	8x8½x12 in.	Water mfg. purposes	150 lb. steam pressure	Worthington Steam Pump Co.
1	Pump	Duplex	16x10x18	Boiler feed	150 lb. steam pressure	Canton Hughes Pump Co.
1	Pump	Duplex	12x12x24	Mfg. purposes	150 lb. steam pressure	Wilson Snyder Mfg. Co.
1	Pump	Duplex	14x10x18	Mfg. purposes	150 lb. steam pressure	Wilson Snyder Mfg. Co.
1	Engine	Corliss	24x42 in.	Rope to alternator	150 lb. initial 2½ lb. back pressure	Vilter Mfg. Co.
1	Turbine	Impulse, four-stage	1250 kv.a.	Direct connected to alternator	150 lb., sat. steam, 3600 r.p.m.	Southwark Foundry & Mach. Co.
1	Engine	High speed	13"x13"	Belted to alternator	150 lb. initial 2½ lb. back pressure	A. L. Ide & Sons
1	Rope drive	American	38 ft. centers	Corliss engine to alternator	14 strands, 1¼ in. rope 1740 ft. long	Dodge Mfg. Co.
1	Generator	Alternating current	550 kv.a.	Main unit	Three-phase, 60-cycle, 440 volt	Allis-Chalmers Co.
1	Generator	Alternating current	1250 kv.a.	Main unit	Three-phase, 60-cycle, 440-volt, 3600 r.p.m.	Crocker-Wheeler Co.
1	Generator	Alternating current	100 kv.a.	Main unit	Three-phase, 60-cycle, 440 volt	Allis-Chalmers Co.
1	Generator	Direct current	30 kw.	Exciter	Belted to 100 kv.a. engine, 125 volt	General Electric Co.
1	Generator	Direct current	25 kw.	Exciter	Motor driven, 125 volt	Allis-Chalmers Co.
1	Motor	Induction	35 hp.	Driving exciter	440 volt, 860 r.p.m.	Allis-Chalmers Co.

The Total Mechanical Power in the United States is estimated at 120,000,000 hp. This includes 19,400,000 hp. in manufacturing industries, 7,700,000 in central light and power stations, about 7,000,000 in isolated plants (exclusive of manufacturing), 3,400,000 in electric railways, 50,000,000 in steam locomotives, 4,000,000 in steamships, 22,500,000 in automobiles and the balance in miscellaneous services such as irrigation, mines, etc.

Draft and Draft Readings

By Osborn Monnett

SYNOPSIS—For smokeless operation with coals of high volatile content, induced or forced draft is not as satisfactory as natural draft. Disadvantages of underground breechings and how to take draft readings.

Induced Draft

There is no question but that induced-draft systems can be so operated as to produce smokeless conditions. In large plants where the fan system is steam driven and installed in duplicate, and where the attendance is first-class, good results can be obtained. An induced-draft system naturally goes with an economizer and such a combination is considered good practice. Economizers on natural draft, however, are of doubtful value, particularly where special brick settings are used to prevent smoke. In such cases the low draft in the furnace is liable to reduce the life of the brickwork and interfere seriously with the combustion.

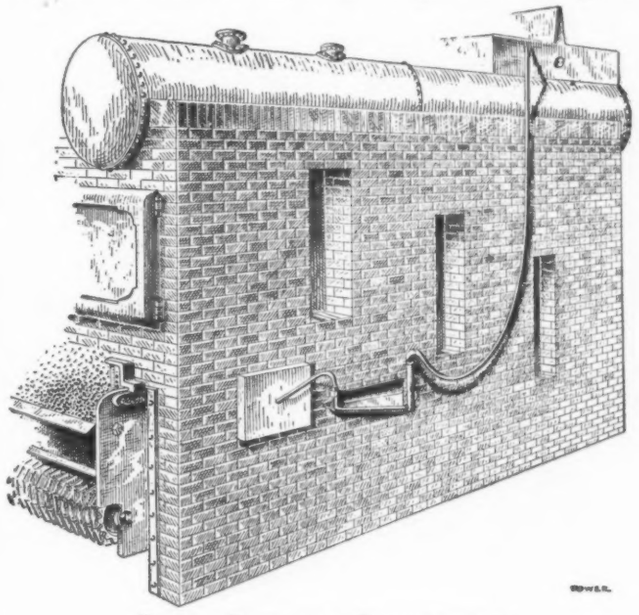
Frequently an attempt is made to increase the capacity of a small plant, where the stack is too small or too low, by installing a motor-driven, induced-draft outfit. This means another piece of equipment to get out of order, and with the frequent blowing of fuses, etc., the plant generally makes as much smoke as before. In the end, the furnace brickwork is usually melted down for lack of draft. Such makeshifts should be discouraged.

Induced draft for hand-fired plants does not work out well when the fan is controlled by the steam pressure. Due to the volatile matter distilling off and an insufficient supply of air, the plant will invariably smoke when the fan slows down. Attempts have been made to train men to fire when the fan speeds up and to cease firing before the steam pressure slows down the fan, so that at periods of low draft there will be a bed of coked coal in the furnace. Such attempts have been failures from a smoke standpoint; it is beyond the capacity of the average fireman to be so machine-like in regularity. An induced-draft outfit, hand-fired, might be clean if the throttle of the fan engine were brought down to the firing floor and manipulated by the fireman according to the condition of the fire. Even then it would be difficult to get a fireman who would operate the plant satisfactorily. As a matter of fact, automatic draft control, depending on the steam pressure, is almost certain to give smoke trouble where coal of 30 per cent. volatile content or higher is used.

In the case of mechanical stokers with induced draft, the control, if any, should be such that the stoker engines will slow down before the induced-draft fan and *vice versa;* otherwise, the fires will smoke. Induced-draft fans should always be steam driven. Motor-driven fans frequently become overloaded and blow fuses when the ash-pit doors are closed. This causes the plant to smoke while repairs are being made. For smokeless operation there is nothing so safe and sure as natural draft.

Forced Draft

Forced draft has its legitimate field in connection with underfeed stokers and for the burning of anthracite coal. For hand-fired installations using high volatile coal forced draft is not conducive to smokeless operation. There is a peak demand for air immediately after firing to take care of the large amount of volatile matter being distilled off at this time. This air can be supplied at the right place and at the right time only by admission over the fire. With forced draft, while air enough is supplied to take care of the fixed carbon in the fuel, air cannot be admitted over the fire in sufficient quantity to burn the volatile matter, the tendency being to blow the gases



Draft Gage and Connections

out into the boiler room. For these reasons the forced-draft, hand-fired installation using high-volatile coals is usually a smoky plant.

Four-Pass Boilers and Underground Breechings

Either of these arrangements call for extra investment in stack to overcome the greater resistance of the setting, and it is doubtful if any net gain results. The underground breeching has disadvantages peculiar to itself. It is out of sight and out of mind, and always imposes more work on the stack. It is difficult to clean without shutting down the plant, and unless the construction is exceptionally thorough it frequently fills up with water.

As usually arranged, the fourth pass has not even the excuse of affording the gases contact with the heating surface and consequently should be avoided. In like manner, passing the gases over the top of the shell in horizontal return-tubular boilers is ill advised, when considered from the overall standpoint. With natural draft such settings are more than liable to cause smoke if capacities much over the boiler maker's rating are attempted. If they have any legitimate field at all, it is in connection with well designed, induced-draft installations, or with underfeed stokers.

Taking Draft Readings

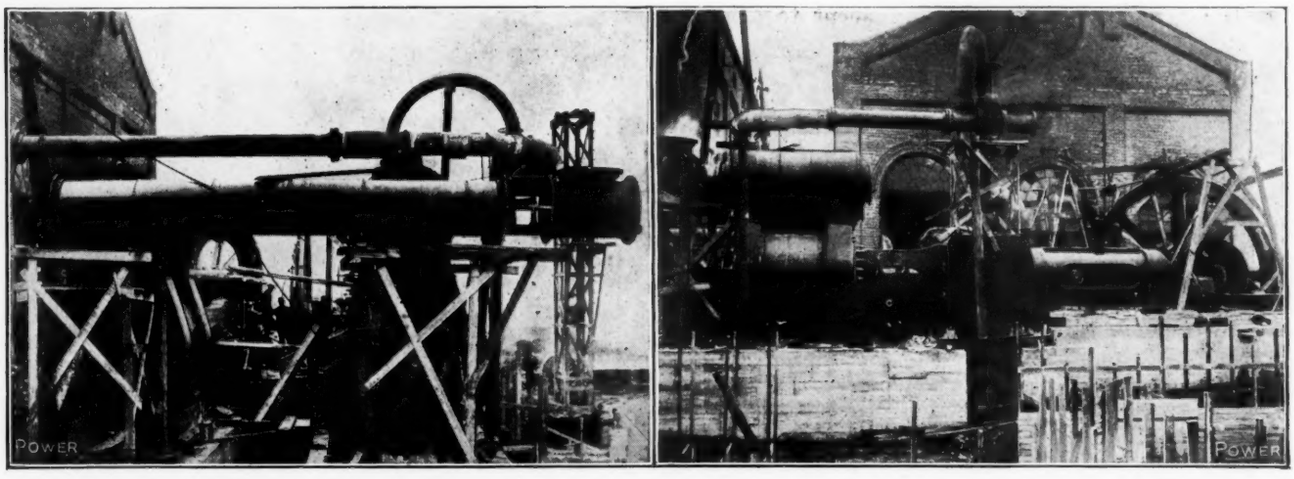
In taking draft readings on boiler plants the old U-tube should be discarded as it is not accurate. A dif-

ferential-draft gage should be used, graduated in hundredths of an inch. The draft over the fire should be taken when the fires are clean and bright shortly after they have been charged with coal, and while the load is normal. A fictitious reading may be obtained where the draft is poor from crowding the furnace with a heavy fire.

In taking the drop through a run of breeching or through a boiler setting, two connections should be made to the draft gage, as indicated in the illustration. The gage then gives an instantaneous reading between the two points and the result is more reliable than a direct reading at each point, as conditions may change between the two readings. The illustration shows how a differential reading is taken to indicate the loss of draft through a boiler setting.

Rapid Erection of a Large Blowing Engine

The Mar. 24 issue described two 900,000-lb. blowing engines, which were built by the Mesta Machine Co., Pittsburgh, Penn., for the Woodward Iron Co. As stated, the high-pressure steam cylinders were 48 in. in diameter and the low-pressure steam cylinders were 84 in. in diameter, with 84-in. air cylinders and 60-in. stroke. The first engine was built in 38 days and both were completed in 59 days. Probably this was the world's record in building large engines and the erection of the same is thought to be the record for the type.



TWO VIEWS OF THE LARGE BLOWING ENGINE DURING ERECTION AT THE PLANT OF THE WOODWARD IRON CO., WOODWARD, ALA.

On Tuesday, Dec. 23, word was sent that the first engine was being shipped from Pittsburgh. The Woodward Iron Co., although anxious to start its new furnace, had done nothing to prepare a foundation, as it was expected that a much longer time would be required to complete the engines; consequently, the ground was covered by a large cinder pile. However, on receipt of the message, work on the foundation was started. By the following Monday evening it was completed and the first casting was in position.

As no overhead cranes were available, it was necessary to resort to makeshift methods in assembling the engines speedily. A railroad track was laid alongside and at each end of the foundation, and a 25-ton railroad crane with an arm of 40-ft. radius procured. The crane was also used for various duties, including repairs about the plant, so that at times the erectors would be deprived of its use for a whole day; therefore, they had to utilize other methods. As an illustration of the difficulties encountered, to get from one end to the other of the foundation, a distance of a few yards, the crane had to travel two miles.

To place the extra-heavy pieces, a skidway built of heavy rails was improvised from the car to the foundation. The heavy castings were then skidded into position above the foundation and lowered by jacks.

To facilitate the erection of the air lines to the furnace, the air cylinders and receivers were placed in position as soon as possible. After this was done, however, it was impossible to use the yard-crane as before, because of the interference with the receiver. An old crane with a useless boiler was then pressed into service and connected to a live-steam line. A cable-way was strung from this to the other crane, at the opposite end of the foundation; in this way it was possible to handle the valves and other engine parts without striking the top of the receivers. When the pistons were ready to be placed it was impossible to get close enough to use the cranes. The pistons were, therefore, put on blocks and rolled into position.

When the first engine was started the steam pressure available was only 60 lb. Before starting the second, however, some of the old engines were shut down and by further changes the steam pressure was raised to 120 lb. The first engine, operating at 60 r.p.m., is used for blowing a new 500-ton furnace. Immediately after starting, it ran for seven days continuously and then was shut down a couple of hours for small adjustments.

The foundation for the second engine could not be

started until all the heavy parts of the first engine had been erected, since the tracks were laid over the ground for the foundation.

Erecting the second engine was as difficult as the first, and it ran for only six hours before it was connected to the furnace.

The engines operated for three weeks in the open air without shelter, and it rained several times; there was also a snowfall of 3 in. Once, the expansion joint on the exhaust line broke, allowing the steam to exhaust directly underneath the engine, which was enveloped in steam for three days before the leak could be stopped.

As the boiler house was near the engines, cinders from the ash heap were blown over them from time to time. This was later stopped to some extent by stretching canvas in front of the engines. As soon as was expedient, a small shed was erected to protect them from the weather until the new power house could be erected.

A Weir Chart

By Ross J. Brower

A couple of years ago it fell to my lot to calculate and plot a number of curves which would show at a glance the water discharged by a particular weir if the depth of water flowing over it were known. And it was from an inspection of the tabulated results of this work that the idea of a chart applicable to all weirs occurred to me.

The work was based upon the Francis formula,

$$3.33\ (\ L - 0.2\ H)\ H^{\frac{3}{2}}$$

in which L is the measured width of the weir in feet, H is the depth in feet of the water flowing over the weir, and the resulting quantity is in cubic feet per second or "second-feet." Multiplying second-feet by 448.8 gives the equivalent in gallons per minute. For small weirs this is a common unit. Francis' formula is ordinarily used where the weir has full end contractions—that is, where all the discharge edges are sharp.

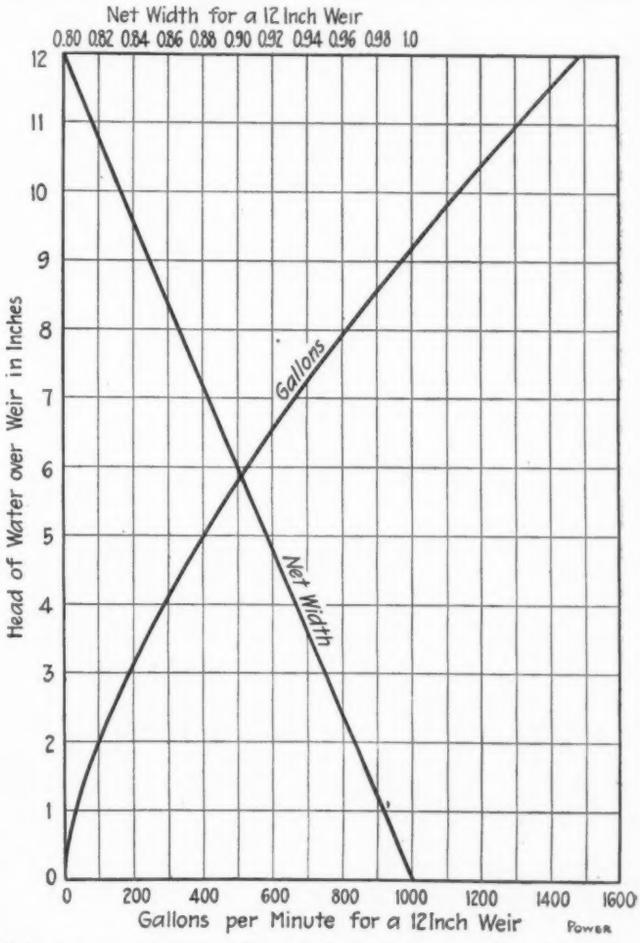
Considering now the factor in the parenthesis, when L and H are both equal to 1 ft., its numerical value is 0.8. Consequently, if the weir measures 2 ft., the stream will measure 1.8 ft.; 3 ft. wide, 2.8, and so on for a depth of flow of 1 ft.

The relation between the depth and the corrected width for a weir 1 ft. wide may be shown graphically by a straight line upon a chart where the depths are marked to scale on a line from the bottom to the top of the chart and the corrected widths are laid off to scale from left to right at the bottom of the chart. The straight line through the two points, $H = 0$, $L = 1$ and $H = 1$, $L = 0.8$, will show the net effective width for any depth of flow.

Now the remaining factors in the formula may also be plotted, using the depth scale already laid off, showing graphically the number of gallons per minute discharged per foot of weir width. In any weir there is only 1 ft. of its whole width which is in any way affected by the contraction produced by the flow past its vertical sides. The true or effective value of this first foot may be read off the straight line for any depth desired. The remaining portion of the measured width not being affected by the end contraction must be added to the effective value of the first foot to get the net effective width of the weir. That part of the formula outside the parenthesis,

$$448.8 \times 3.33\ H^{\frac{3}{2}}$$

is but an expression for the quantity of water in gallons per minute discharged over each lineal foot of width.


Net Width for a 12 Inch Weir
0.80 0.82 0.84 0.86 0.88 0.90 0.92 0.94 0.96 0.98 1.0
Head of Water over Weir in Inches
Gallons
Net Width
0 200 400 600 800 1000 1200 1400 1600
Gallons per Minute for a 12 Inch Weir
Power

Select a convenient gallon scale and for a series of depths compute the numerical values of the above expression and plot the corresponding curve upon the chart.

It is now possible to get the discharge over any weir. For a depth of, say, 6 in., read the effective width of the first foot off the chart as 0.9 ft.; following this 6-in. line to its intersection with the gallon curve, read 530 gal. per min. per ft. of effective width. If the weir is 4 ft. wide, then the effective width must be 3.9 ft. and the discharge over the weir must be

$$3.9 \times 530 = 2067\ gal.\ per\ min.$$

Thus by simple multiplication the discharge over a weir of any width is readily determined.

Appalachian Oil Production in 1913—During 1913 the Appalachian oil field, embracing New York, Pennsylvania, West Virginia, southeastern Ohio, and Kentucky, showed a slight decline—1.72 per cent.—in the production of petroleum, falling from 26,338,516 barrels in 1912 to 25,885,640 barrels in 1913—a decrease of 452,876 barrels. The value, amounting to $63,619,677 in 1913, was, on the contrary, increased by 48.58 per cent., about the same proportional increase as was shown in 1912 over the previous year. The figures for each district were as follows:

State	1912	1913
New York	874,128	902,211
Pennsylvania	7,837,948	7,927,137
West Virginia	12,128,962	11,567,299
Southeastern Ohio	5,013,110	4,964,425
Kentucky	484,368	524,568
Total	26,338,516	25,885,640

Stresses in Convex Heads

By F. G. Gasche*

SYNOPSIS—A mathematical analysis of the stresses prevailing at the flange fillet of convex heads. The conclusion is reached that the radius at this point should be as small as possible, although sharp corners must be avoided.

Recent communications concerning boiler explosions† have indicated sufficient reasons for a critical examination of the formulas by which the important elements of boiler and tank construction are usually estimated. As pointed out by T. T. Parker (Jan. 13 issue), there is a serious omission of the efficiency of rivet joints from the formula for convex heads, particularly those that have to be applied to tanks of large dimensions. Where a head can be flanged from a single plate, the element of safety is thought to be satisfied by the insertion in the formulas of the usual factor of safety, on the supposition that there can be no question concerning the actual stresses existing in any part of the plate. Notwithstanding these calculations and the use of plates of greater thickness than the rules would specify, we occasionally learn of the failure of large convex heads. Unfortunately, the examination of such fractured boiler elements frequently reveals corrosion, crystalline structure, overheating, or initial cracks —any one of which is reprehensible, but nevertheless thought sufficient to explain the primary cause of failure, and quite apart from the question of the weakening effect of rivet joints.

It will be observed that a great many of the failures of convex heads have been at or near the crown of the flange fillet between the spherical shell and the cylindrical flange. So frequently has this been the region of plate fracture that it was thought advisable to examine the nature of stresses at this point with the hope that more suitable formulas may be evolved. For this purpose the following notation will be employed:

p = Hydrostatic pressure, lb. per sq.in.;
s' = Tensile stress in a spherical shell, lb. per sq.in.;
s_1 = Maximum fiber stress at surface of plate due to stress couple, lb. per sq.in.;
$s = s' + s_1$ = Maximum tensile stress, lb. per sq.in.;
U = Ultimate tensile strength of the plate, lb. per sq.in.;
P = Vertical component of hydrostatic pressure on the particular surface element shown in Fig. 2, lb.;
R = Resultant of hydrostatic pressure on element $ABCDA$ in Fig. 3, lb.;
T = Resultant of all stresses s on the unit area $a\,t$ of section CD, Fig. 3, lb.;
S = Resultant of all stresses on element $a\,t$ of section AB, Fig. 3, lb.;
Q = Reaction on element $CDEFC$ by a *rigid* cylindrical drum, lb.;
t = Thickness of plate in convex head, in.;
a = Width of small radial element shown in Fig. 2, in.;
r = Internal radius of spherical head, in.;
r_1 = Internal fillet radius of the flange extension, in.;
α = Angle of fillet portion of flange extension, deg.;
F = Factor of safety;
E = Efficiency of rivet joints;

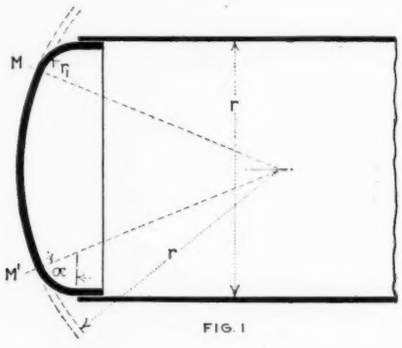


FIG. 1

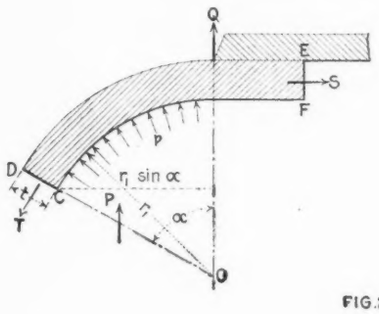
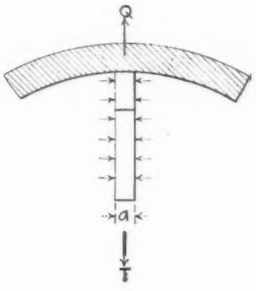


FIG. 2



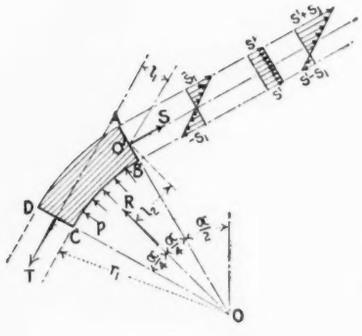


FIG. 3

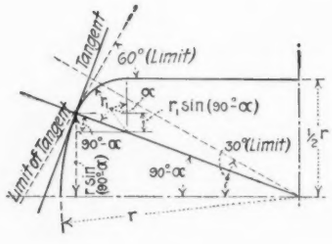


FIG. 4

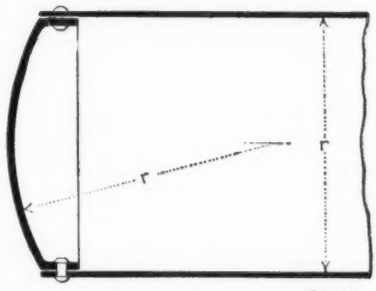


FIG. 5

*Mechanical engineer, Illinois Steel Co.
†See "Power," Jan. 13 and May 19, 1914.

l_1 = Lever arm of force S about the center O' in Fig. 3, in.;

l_2 = Lever arm of force R about the center of O' in Fig. 3, in.;

I = Moment of inertia, $\frac{at^3}{12}$, of exposed rectangular section of plate about a gravity axis.

The stress in a spherical shell is given by the following simple formula as developed in mechanics:

$$s' = \frac{rp}{2t} \tag{1}$$

If there are rivet seams on the surface of the spherical shell then a safe thickness would be derived from the formula,

$$t = \frac{rpF}{2Es'} \tag{1a}$$

where F is the factor of safety and E is the efficiency of rivet joints. The stress s' is a simple tensile stress in any tangential direction at any point of a thin spherical shell, and it remains constant for given values of the radius r and the internal pressure p.

This is true for the boundaries M and M', Fig. 1, of a spherical disk formed by the intersection of the shell by a cone having its vertex at the center of the sphere. At such boundaries may be joined other extensions of the plate which do not lie in the spherical surface and yet are surfaces of revolution. Such surfaces form the connection to cylindrical drums and are subject to stresses additional to those of formula (1) in accordance with the local form and dimensions of the plate.

A small portion, $CDEFC$, of a radial element of the plate is shown in section and side view in Fig. 2. The width of the element is supposed to be a small quantity a such that the sides are parallel; the thickness is t, making no allowance for change of thickness due to flanging operations. The element is subject to forces T and S perpendicular to the imaginary end sections, to a restraining force Q, due to the cylindrical drum, and to the hydrostatic (normal) pressure p. There are other forces normal to the sides of the element which occur in pairs and are directly opposed to each other, as shown in the end view, Fig. 2. These forces do not enter the equations for equilibrium of the element.

Taking moments about the point O, Fig. 2, through which the lines of action of all forces p and Q will pass, we find

$$S = T \tag{2}$$

The resultant in a vertical direction of all the hydrostatic pressures on the flange-fillet section is

$$P = p\,a\,r_1 \sin \alpha \tag{3}$$

The sum of all the vertical forces on the element is zero; hence

$$P + Q - T \sin \alpha = O \tag{4}$$

From consideration of formulas (1) and (2) there are operating on the end faces of the element, as areas $a\,t$, the total forces

$$S = T = ats' = \frac{arp}{2} \tag{5}$$

and, substituting the values from (3) and (5) in equation (4),

$$Q = ap\left(\frac{r}{2} - r_1\right) \sin \alpha \tag{6}$$

For all practical cases $\frac{r}{2}$ is greater than r_1. The force Q is, therefore, radial as applied to the flange extension of the convex head and tends to open the joint between the head and the cylindrical drum irrespective of the rigidity of the drum. For the sake of simplicity in the analysis it is necessary to assume a perfectly rigid cylindrical drum as a basis for establishing the numerical value of Q. A yield of the structure at the flange connections would seriously complicate the stress-strain relations.

Experiments reported in *Engineering*, to which reference is made in POWER of Jan. 13, 1914, seem to indicate that there is a maximum distortion and presumably maximum stress in the head at about the middle of the curve of the flange fillet corresponding to the section AB of Fig. 3. For the present purpose it is assumed that the "dangerous section" is located at the plane AB.

The portion $ABCDA$, Fig. 3, of the element $CDEFC$ is balanced under the following system of forces taking O' as the origin on the neutral axis of the element.

1. A stress couple at the section AB.
2. A uniformly distributed stress due to the force S.
3. Certain shear stresses on the plane AB having no moment with reference to O' and not shown on the figure.
4. The external forces R, S and T.

There are no shear stresses on the plane CD.

The resultant of the normal hydrostatic pressure p on the element $ABCDA$ is

$$R = 2\,apr_1 \sin \frac{\alpha}{4} \tag{7}$$

Its line of action passes through the center O and is inclined to the vertical by an angle $\frac{1}{4}\,\alpha$.

The lever arms of R and T about O' are, respectively,

$$l_2 = \left(r_1 + \frac{t}{2}\right) \sin \frac{\alpha}{4} \tag{8}$$

$$l_1 = \left(r_1 + \frac{t}{2}\right)\left(1 - \cos \frac{\alpha}{2}\right) \tag{9}$$

Taking the moment equation about O', with counter clockwise direction as positive,

$$-2\frac{s_1 I}{t} + Tl_1 - Rl_2 = 0 \tag{10}$$

Hence, substituting the equivalent values in (10) and considering that

$$2 \sin^2\left(\frac{\alpha}{4}\right) = 1 - \cos \frac{\alpha}{2}$$

we derive

$$s_1 = \frac{6p}{t^2}\left(r_1 + \frac{t}{2}\right)\left(\frac{r}{2} - r_1\right)\left(1 - \cos \frac{\alpha}{2}\right) \tag{11}$$

The sign of the term involving the trigonometric function is always positive for such angles as would apply to the ordinary dished heads and flanges. We may, therefore, conclude that s_1 is a tension at the point A and a compression at the point B of section AB of Fig. 3. The fillet angle α cannot be less than 60 deg. for the ordinary ratio of drum diameter to radius of spherical head (unity) and seldom exceeds 70 deg.

From (1) and (11), the maximum tensile stress per square inch on the plate at the section AB is (12)

$$s = s' + s_1 = p\left[\frac{r}{2t} + \frac{6}{t^2}\left(r_1 + \frac{t}{2}\right)\left(\frac{r}{2} - r_1\right)\left(1 - \cos \frac{\alpha}{2}\right)\right]$$

When the internal radius r of the spherical head is equal to the inside diameter of the cylindrical drum, the relation between r, r_1 and a are as shown in Fig. 4, where

$$r \sin (90° - a) - r_1 \sin (90° - a) + r_1 = \tfrac{1}{2} r \quad (13)$$

giving

$$\cos a = \frac{\frac{1}{2} r - r_1}{r - r_1} \quad (14)$$

NUMERICAL EXAMPLE—ALL DIMENSIONS ASSUMED

$r = 90$ in.;
$r_1 = 1.5$ in.;
$t = 0.75$ in.;
$p = 160$ lb. per sq.in.

From (14),

$$\cos a = \frac{45 - 1.5}{90 - 1.5} = \frac{43.5}{88.5} = 0.4915 = \cos 60° 33'$$

Then

$$a = 60° 33', \frac{a}{2} = 30° 16\tfrac{1}{2}', \text{ and } \cos \frac{a}{2} = 0.8636$$

From (1),

$$s' = \frac{90 \times 160}{2 \times 0.75} = 9600 \text{ lb. per sq.in.;}$$

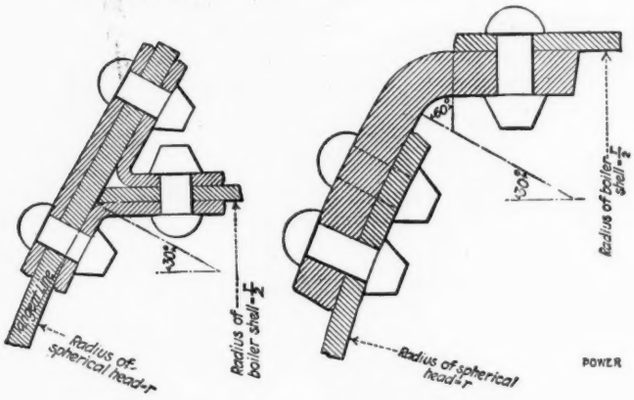


FIG. 6. FIG. 7.

Fig. 6. Proposed Flange Connections for Large Drums, Convex Heads and Moderate Pressures. Fig. 7. Proposed Flange Connections for Large Drums and Convex Heads with High Steam Pressures.

From (11),

$$s_1 = \frac{6 \times 160}{0.5625}(1.5 + 0.375)(45 - 1.5)(1 - 0.8636);$$
$$= 1707 \times 1.875 \times 43.5 \times 0.1364 = 19{,}000 \text{ lb. per sq.in.;}$$
$$s = s' + s_1 = 28{,}600 \text{ lb. per sq.in.}$$

This is the maximum tensile fiber stress at the exterior of the flange fillet.

If by such calculations the value of s is found to exceed the elastic limit of the material forming the head, then a set will be produced in the plate, leading to a new and smaller radius r_1 and angle a of the fillet portion. The set which the plate may receive by these stresses permits of some deformation of a portion of the spherical shell which assumes a new and smaller radius r, thus causing a new and more favorable value of the stress s_1, both in magnitude and direction, and a decrease in demands for support on the part of the material in the flange fillet.

The investigation is now sufficient, within the limits of the premises upon which it is based, to indicate that the support of very large spherical heads at their edges should not depend on flange fillets of large radius. On the contrary the fillet radius r_1 should be as small as the circumstances of the manufacture of convex heads will permit, even for moderate sizes of boiler drums. This is a necessary elaboration of the simple requirement that circular rivet seams at the ends of cylindrical drums should be as near to the tangents of the spherical shell at that region as it is structurally possible to place them. For small drums, Fig. 5 shows what form is desirable from the consideration of strength of the head, though it must be understood that sharp corners of flanged plates are not to be tolerated. Fig. 6 is a suggestion of the manner of attaching spherical heads to drums of large diameter as applied to large tanks and relatively small internal pressures. Fig. 7 is a suggestion for large drums intended for high steam pressures.

Formula (11) is proposed for the general conditions involving accidental values of p, r, r_1, t and a. For reasons mentioned above we cannot expect much variation of the fillet angle a, and for the purpose of an empirical formula it will be assumed as 60½ deg. The value of $\left(1 - \cos \frac{a}{2}\right)$ then becomes 0.136. We will also for the same purposes assume that the internal radius r_1 of the fillet is twice the thickness t of the plate. Formulas (11) and (12) then become, respectively,

$$s_1 = 1.02 \frac{rp}{t} - 4.08\, p = 1.02\, p \left(\frac{r}{t} - 4\right) \quad (15)$$

and

$$s = s' + s_1 = 1.52 \frac{rp}{t} - 4.08\, p = 1.52\, p \left(\frac{r}{t} - 2.68\right) \quad (16)$$

The values of the quantity $4.08\, p$ are relatively small as compared with the values of the quantities $1.02 \frac{rp}{t}$ and $1.52 \frac{rp}{t}$ and, therefore, can be dropped from the empirical equations, thus giving somewhat larger values of the stresses, as follows:

$$s_1 = 1.02 \frac{rp}{t} \quad (15a)$$

and

$$s = s' + s_1 = 1.52 \frac{rp}{t} \quad (16a)$$

The maximum *safe allowable* stress is of particular importance in determining proper values for the construction of dished heads. Such values are obtained by considering a factor of safety F and the efficiency of rivet joints E in connection with the ultimate strength U of the plate. Then we have from (16a) for the *safe allowable* stress s,

$$s' + s_1 = s = 1.52 \frac{rp}{t} = \frac{UE}{F} \quad (17)$$

and

$$t = 1.52 \frac{rpF}{UE} \quad (18)$$

In using formulas (17) and (18) it must be clearly understood that they are entirely empirical and are based on a fillet radius of twice the thickness of the plate, and require the specification of the various quantities in the following terms:

s' = Tensile stress in pounds per square inch, due to internal hydrostatic pressure on the spherical portion of the convex head;

s_1 = Maximum fiber stress in pounds per square inch, due to the hydrostatic pressure causing a bending action in the plate at the crown of the flange fillet;

s = Maximum tensile stress in pounds per square inch at the crown or outer fiber of the flange fillet;

p = Hydrostatic pressure of steam, water or gas in pounds per square inch of the internal surface;

r = Internal radius in inches of spherical portion of dished head (taken equal to inside diameter of cylindrical drum);

t = Thickness in inches of plate forming the convex head at the fillet.

Comparison of Calculations for Convex Boiler Heads Based on Various Rules

These are based on the assumption that the diameter of the cylindrical drum is equal to the radius of the convex head. The formulas are reduced to the consideration of a convex head without rivet joints on its surface, using a factor of safety of 5 and a tensile strength of 55,000 lb. per sq.in.

Massachusetts, Ohio and U. S. Government

$$t = \frac{rpF}{2U}, \qquad p = \frac{2tU}{rF} \qquad \text{(I)}$$

T. T. Parker

$$t = \frac{8.33\,rp}{2U}, \qquad p = \frac{2tU}{8.33\,r} \qquad \text{(II)}$$

F. G. Gasche

$$t = 1.52\frac{rpF}{U}, \qquad p = \frac{tU}{1.52\,rF} \qquad \text{(III)}$$

Case 1. Diameter of drum 48 in., thickness of head 0.75 in. To find the allowable pressure.

By formula (I), p = 344 lb.
By formula (II), p = 206 lb.
By formula (III), p = 113 lb.

Case 2. Diameter of drum 90 in.; thickness of head 0.75 in. To find the allowable pressure.

By formula (I), p = 183 lb.
By formula (II), p = 110 lb.
By formula (III), p = 60 lb.

Case 3. Diameter of drum 42 in.; pressure 200 lb. per sq.in. to find the thickness.

By formula (I), t = 0.382
By formula (II), t = 0.636
By formula (III), t = 1.162

Volume Regulator for Air Compressors

A new volume regulator, which can be applied to air compressors to control the amount of intake air and reduce the power required to operate the compressor in about the same proportion, is manufactured by the Hall Steam Pump Co., 201 Galveston Ave., Pittsburgh, Penn. By its use, the amount of intake air can be regulated to correspond to the compressed air consumed at any time, thereby keeping the receiver pressure constant, and any desired constant volume within the capacity of the compressor can be delivered. It can be applied to any kind of air compressor with automatic inlet or outlet valves, or both.

The feature of this regulator is that, in case the automatic suction valves are used for regulation, they are kept open by force during a part only of each discharge stroke and close as soon as the intake air remaining in the cylinder has decreased, so as to correspond to the compressed air desired at the time.

If the automatic discharge valves are used for regulation, they remain forced open during a part only of the following suction stroke, and close as soon as the compressed air returned into the pump cylinder is so great that, after expansion to the intake pressure, it will leave sufficient room for the entire quantity of compressed air to enter the cylinder during the last part of the suction stroke.

Closing the automatic valve at an adjustable point during the return flow of the air is effected in a gradual regulation of the force holding the valve open against the pressure exerted by the spring. The return flow of the air through the valves produces a pressure tending to close them, which will constantly increase until the piston has reached the end of its stroke, or very nearly so. The valve will close at the point where this pressure, supported by the pressure of the valve spring, balances or overcomes the force applied for the purpose of regulation.

Fig. 1 shows the application of the regulator to an ordinary poppet-valve air compressor and acting upon a suction valve to keep the receiver pressure constant. The main piston works in a power-driven compressor cylinder. The suction valves have springs which tend to close them, and pistons which are acted upon by the air pressure in their cylinders. These cylinders are connected by a pipe to the auxiliary tank. The latter communicates with the atmosphere through a leak, and with the main reservoir through the opening, which is closed by the automatic needle valve as soon as the force of the adjustable spring above it overcomes the air pressure of the reservoir, acting on the bottom of the needle-valve piston.

An adjustable hand needle valve can be arranged to obtain a constant leak from the main to the auxiliary reservoir, thereby preventing the pressure in the latter from decreasing below a certain value.

When the compressor is working at a constant partial load, the automatic needle valve will allow some air to enter the auxiliary tank through the valve opening, and the same quantity of air will escape through the leak to the atmosphere, thus keeping the pressure in the reservoir and the pressure acting on the piston in the main cylinder constant. The suction valve will close at such a point of the discharge stroke as to compress exactly the quan-

tity of air consumed, the pressure in the storage tank remaining at constant.

An increase or decrease in the consumption of air will cause a slight momentary decrease or increase of the pressure in the main tank and the air entering the auxiliary reservoir through the needle valve will decrease or increase. This so changes the pressure in the reservoir and the cutoff of the suction valve as to increase or decrease the intake air until new conditions of equal supply and consumption of compressed air are established at the same pressure as before.

For a certain pressure in the auxiliary tank, the air compressor will work at its maximum capacity. The object of the adjustable needle valve is to admit constantly so much air to the auxiliary tank as to produce this pressure. If more air be admitted through the hand needle valve, the capacity of the compressor will be reduced and the volume of the intake air will vary with the consumption only as long as the latter remains below its reduced capacity.

Owing to the low pressure thus carried in the plungers of the discharge valves they will be kept open during part of the following stroke, and allow a certain amount of compressed air to reënter the cylinder from the outlet passage and expand in the cylinder to the intake pressure. During the remaining part of the suction stroke, the fresh air drawn into the cylinder will correspond exactly to the consumption of compressed air at the time, the air in the main tank remaining constant.

When the compressed-air consumption is increased, a slight momentary drop of pressure in the main tank results. The spring above the needle valve will then overcome the effect of the tank pressure on the piston and it will rise, thereby allowing the needle piston carrying the needle valve to lift and a greater quantity of air from the tank will enter the auxiliary chamber. The pressure in the auxiliary tank will increase, and acting through the discharge-valve plunger will cause the discharge valve to seat at an earlier point of the suction stroke. This increases the volume of fresh air drawn into the compressor

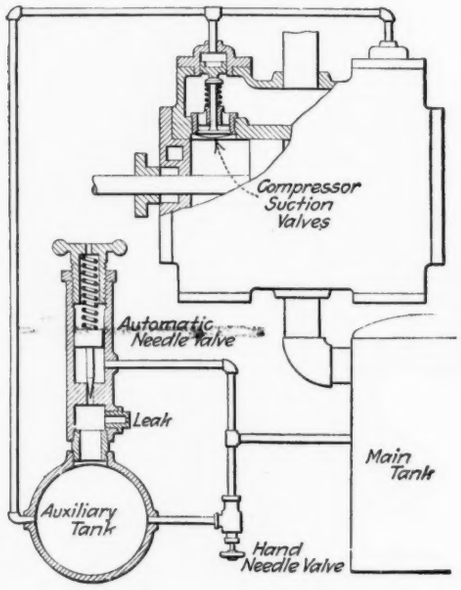


FIG. 1. APPLICATION OF THE REGULATOR TO POPPET-VALVE AIR COMPRESSOR

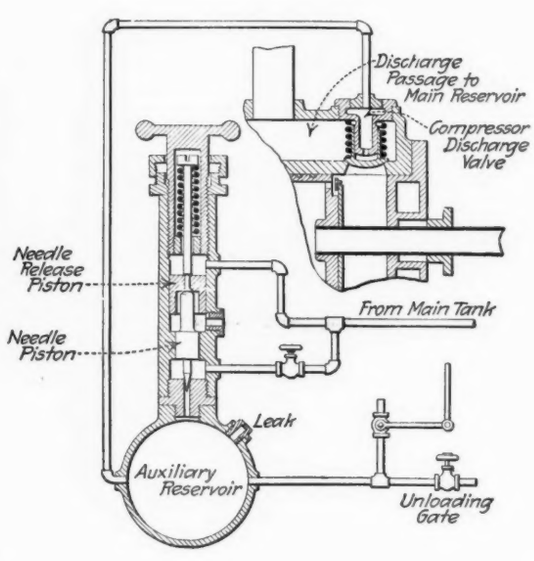


FIG. 2. APPLICATION TO REGULATION OF DISCHARGE VALVE OF PISTON-INLET TYPE COMPRESSOR

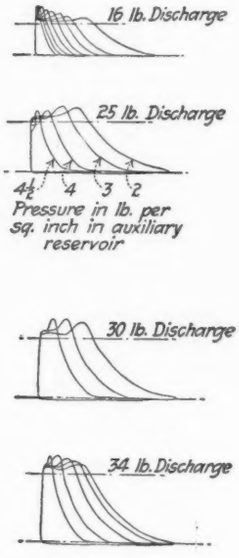


FIG. 3. INDICATOR DIAGRAMS FROM PRESSURE-REGULATED COMPRESSOR

Fig. 2 shows the regulator applied to a compressor having piston-inlet type of discharge valves.

When the compressor is working at a constant partial load, the air under pressure from the main tank will enter the chamber above the needle-valve release piston, through the pipe shown, and counteract the tendency of the spring to raise the piston, which will therefore bear upon its extension, so carrying the needle valve against the pressure entering the chamber through the pipe that the air will enter the auxiliary reservoir through the passage shown at the same rate as it escapes through the leak. This will keep the pressure in the reservoir constant, which, through the pipe leading from it and the opening shown, acts upon the cylindrical discharge valve. Under these conditions, the pressure in the auxiliary chamber will be somewhat less than that in the main tank and in the passage leading from the cylinder to that tank.

through the intake valve until it equals the increased consumption of compressed air taken from the main tank, the pressure in the tank being kept the same as before.

In case of a decreased consumption, similar action will take place and a new equilibrium between the supply and the consumption will be established after a slight momentary increase of the tank pressure.

The unloading globe valve allows enough of the pressure air in the auxiliary tank to escape to the atmosphere to load the compressor by hand if desired. A similar valve is opened by means of a speed regulator, if the speed of the prime mover falls below a certain value and it is desired to unload the compressor in that case.

Fig. 3 shows a series of indicator diagrams taken in a service test on an ordinary poppet-valve air compressor, with bypass, equipped with the volume-regulating device.

Bristol Pneumatic and Electrical Recording Tachometers

The Bristol pneumatic-type recording tachometer has been developed to continuously record the speed of shafting and machinery. A special feature of this tachometer, Fig. 1, is the 25 or more feet of flexible connecting tube between the revolving mechanism and the recording instrument, which may be mounted in any convenient position. The instrument is manufactured by the Bristol Co., Waterbury, Conn.

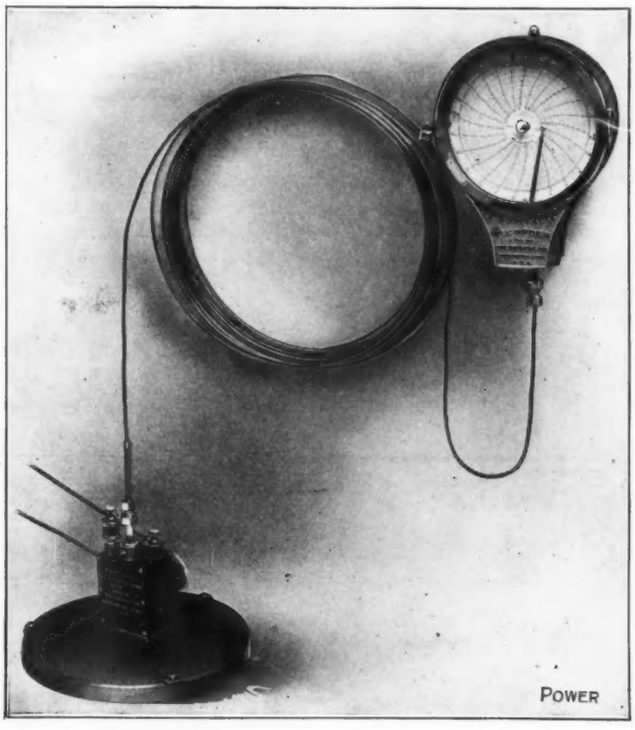


FIG. 1. RECORDING TACHOMETER

The pneumatic principle of operation depends on the centrifugal action of air in a revolving tube which is connected to the recorder through a special oil-seal, flexible connecting tube. The hollow circular protecting base at its upper surface is provided with a bearing for a hollow shaft *D*, Fig. 2, arranged to be rotated from any desired mechanism through a set of gears and pulleys or sprockets.

The pulley *C* is belted to a similar pulley attached to the shaft whose revolutions are to be measured and recorded. The lower end of the hollow vertical shaft *D* terminates in a horizontal tube *A*, open at its extremities. The upper end of the hollow shaft is surrounded by a casing *E*, and is partly filled with oil; into this extends the free end of a stationary tube joined at its outer end to a flexible capillary connecting tube *G* leading to the recording instrument. The recorder used is a special, low-range recording vacuum gage.

The Bristol electric tachometer of the alternating-current type, Fig. 3, is suited to rough operating conditions in mills, power plants or shops. Two of its main features are the induction magneto and the voltmeter movement. The magneto, being of the induction type, is without any sliding contacts or brushes. The indicating and recording instruments are voltmeters. The indicating instrument has a Weston pivot jewel-bearing voltmeter movement, and the recording instrument has an improved Bristol voltmeter movement designed with enough power for actuating the recording arm with the pen in contact with the chart. The movement is mounted on frictionless knife-edge bearings and has a new supporting device for the moving elements designed to eliminate temperature error. This recorder can be furnished for either 6-, 8- or 12-in. charts.

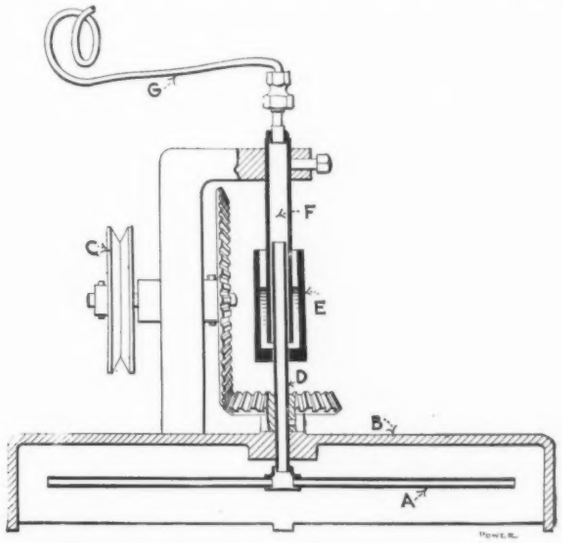


FIG. 2. DETAILS OF REVOLVING MECHANISM

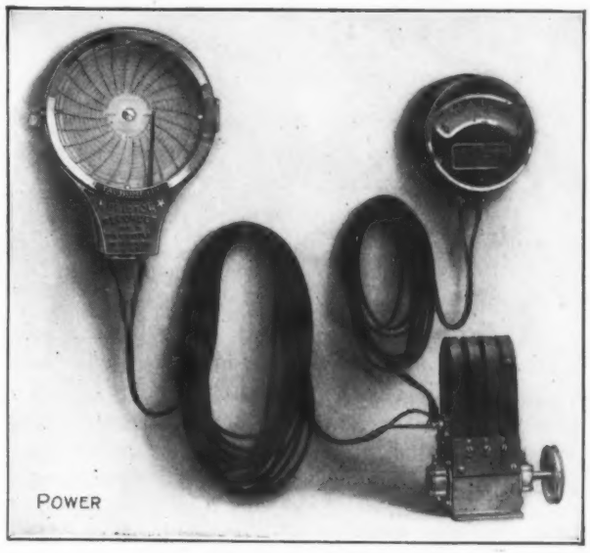


FIG. 3. ELECTRICAL TACHOMETER

Suitable lengths of leads can be furnished for placing either instrument at desired points and there are connections for more than two instruments. A simple form of this tachometer can also be had either with the indicator or the recorder alone.

Coal Mining in Indiana—The first commercial coal mining in Indiana, according to E. W. Parker, of the United States Geological Survey, was done by the American Cannel Coal Co., at Cannelton, Perry County, in 1837. The coal was mined along the Ohio and Wabash rivers. In 1840 the production was 9682 tons. The record for production was made in 1910, when it was 18,389,815 tons; the production for 1913 was 17,165,671 tons.

Tom Hunter, Hoisting Engineer

By Warren O. Rogers

SYNOPSIS—We find a combination of electrical units whereby either the small direct-current and alternating-current unit could be run as a motor or generator. This permitted shutting down at times either the direct-current or alternating-current main, engine-driven units and still generate direct and alternating current. At another mine a combination haulage system was operated, using a second-motion haulage engine and an electric locomotive.

Cresson, Penn., is at the top of the mountain, and is accustomed to hand out all kinds of weather. Hunter and I reached the town the next forenoon after our uncomfortable night with bug exterminators and paint. The sun was shining, but an overcoat felt comfortable, especially when a cloud covered the sun and a driving snow squall would rage for half to three-quarters of an hour. We experienced several of them that day.

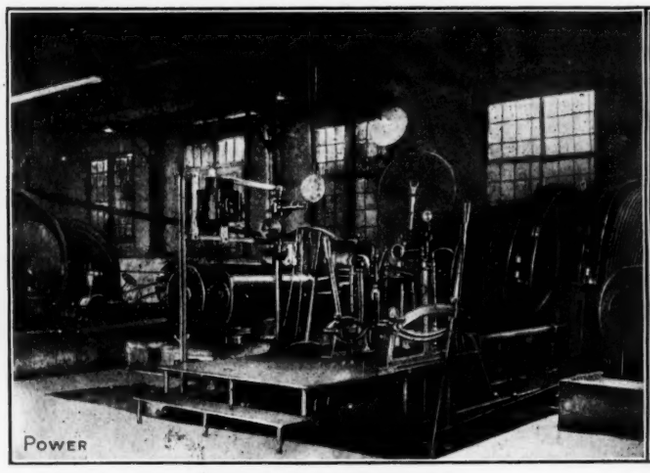


Fig. 1. Hoisting Engine in the Main Engine Room

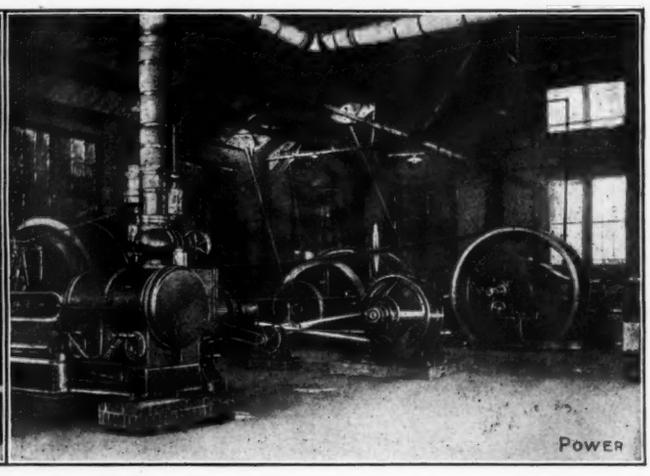


Fig. 2. The Two Reciprocating Units Belted to Generators

Obtaining permission at the office of the Pennsylvania Coal & Coke Co. to inspect the outside mine workings, we first went to Cresson No. 9 shaft. Here we found a 24x42-in. first-motion hoisting engine, Fig. 1, with an 8x10-ft. drum working on a shaft 530 ft. deep. Two veins were worked, one being at the 300-ft. level.

This engine was housed in one end of the power plant which consisted of one 15 and 25 by 15-in. tandem-compound, side-crank engine, belt connected to a 200-kw. alternating-current, two-phase, 60-cycle, 2300-volt generator at 900 r.p.m. This unit was used to light the town of Cresson.

"A central station at the mines," remarked Hunter upon being told of the use to which the units were put.

"This unit," said the superintendent, who was showing more friendly attention than we had any right to expect, "has a 20x21-in. cylinder and is directly connected to a 200-kw., 250-volt, direct-current unit for mine use.

"We have a combination in those two units and the two motors that is exceptionally convenient. The alternating-current machine lights the town at night, as I have said. The direct-current generator supplies the mine day and night when the mine is working. In case of a shut down of the mine the direct-current machine is stopped and the alternating-current generator is not only used for commercial circuits, but also to operate a 100-kw. alternating-current motor, which belt-drives a 90-hp. motor used as a 250-volt, direct-current generator to supply electrical energy to the mine for whatever purpose desired up to the capacity of the machine.

"When the mine is operating, the large direct-current generator is used, but the 90-hp. motor which was driven as a direct-current generator is run as a motor from the large direct-current generator and drives the 100-kw. alternating-current motor as an alternating-current generator for lighting the town and mine. Of course, these machines are all controlled from the switchboard.

"One of the greatest difficulties in operating electrical units about a mine is in keeping them clean, especially if they are of the open type."

"That's right," agreed Hunter, "I once saw a good-sized direct-current generator get on fire in the inside of the armature winding. The engineer, feeling a little chesty had blown himself to a cigar and was smoking it while on duty. A spark from the cigar was drawn into the armature, which set fire to the accumulation of dirt, and it was not long before the engineer found the machine smoking like a young volcano. The machine had to be shut down while the engineer was busy attempting to kill the fire, and, fortunately, was successful before the armature was damaged."

"We have found," resumed the superintendent, "that for our particular circumstances and conditions that it is to our interest, taking all things into consideration, to purchase considerable electrical energy. For that reason we have several substations for converting purchased high-voltage alternating current into direct current for use in the mines."

After some further talk we proceeded to one of the substations, Figs. 3 and 4, located at the Gallitzin No.

10 slope. Here we found a neat brick building in which was a motor-generator set on one side of the room and the transformer for reducing the line current down for motor use. The energy came to the transformer at 4500 volts and was transformed down to 2300 volts to drive the 430-hp. synchronous motor which was directly connected to a 1090-amp. direct-current generator which supplied the five 13-ton electric locomotives used in the main haulage, two 3-ton gathering locomotives and 16 electric chain cutting machines. Direct current is necessary in mine electric locomotives because alternating-current motors do not satisfy the speed and space requirements. That is why rotary converters are used in so many mines taking high-voltage alternating current and transforming it down to low-voltage direct current."

"Yours is not the only mine that has found the rotary converter to be useful as well as reliable. Many of the larger mining companies have built central power plants, either steam or hydraulic, at suitable points, and transmit the high-tension alternating current to the mine, miles away, where it is converted to direct current. Generally this current is used at either 275 or 600 volts."

"What is the reason the substations are always on top of the mine?" I asked as we made our way back to the railroad station.

"They are not," replied Hunter. "In some of the large mines it is sometimes advisable to locate the converters underground near where the converted current is to be used. Such a station should be lined with brick, and made waterproof on the outside. The ceiling should also be water-tight so that dripping water cannot damage the machine. The high-tension current is generally led to the underground substation by armored lead-covered cables through bore holes, which lessens the chances of injury from falling rocks, etc."

We had inspected, some weeks previous, the substation at Truesdale colliery in which was a 500-kw. rotary converter taking current at 4000 volts from the power plant and sending it out for direct-current use at 275 volts. A second rotary converter of about one-half the capacity also supplied 275-volt current for mine use. The alternating side of these machines ran on six-phase, 60-cycle current at 450 and 900 r.p.m. respectively. The units are shown in Fig. 5.

Arriving at the railroad station we waved a farewell to our host from the rear platform and then went into the smoking compartment to punish a couple of stogies.

"I should think there would be danger of shock from those overhead trolley wires," I said as I mentally calculated the amount of clearance that must have been between my head and the wire in the last mine we had been in.

"There is," said Hunter, shifting one leg over the other. "There are three dangers from electricity in mines; that from shock of touching the trolley line or other base conductor or from touching something that, through worn insulation, has become charged with electricity. Then there is the danger of a spark setting off gas or dust, which may occur when a motor is working under a heavy load.

"While the sparks from a motor would not be sufficient to ignite coal dust the flash from an open circuit might, or the flash from a heavy short-circuit would be dangerous. The danger from fire is due to the vicinity of inflammable material to a flashing motor or a circuit wire grounding. I have been told that certain sizes of incandescent lamps will, if broken, ignite any surrounding explosive mixture of gas and air.

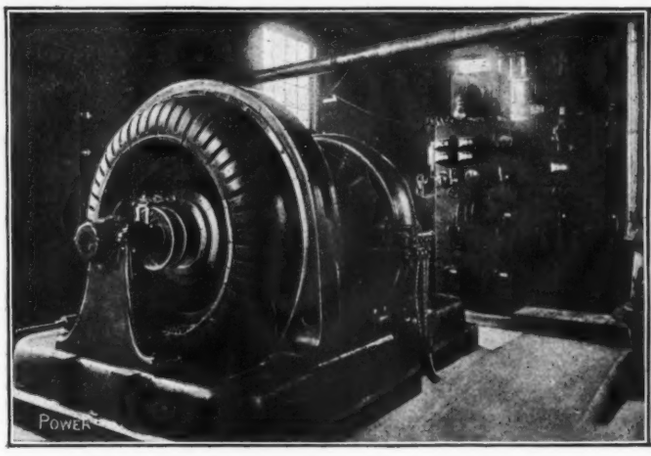


FIG. 3. MOTOR-GENERATOR UNIT

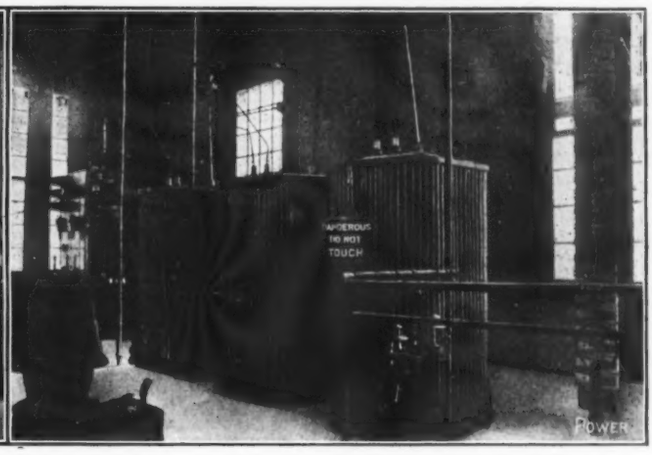


FIG. 4. HIGH TENSION TRANSFORMERS

"Electricity in coal mines has made great strides in recent years. According to the Bureau of Mines, in Pennsylvania, from 1902 to 1911, the horsepower developed at anthracite mines had increased from 354,223 to 671,802. Most of this increase was underground work, pumps, etc., but the increase for electric locomotives was from 53 to 635 in number. You can see that where these machines are used the mule has had to step to one side. In the anthracite mines there are said to be more than 15,600 mules, each worth about $250, something like $3,900,000. As the average life of the mine mule is about five years, there are $780,000 expended each year for mine mules. That rather knocks the mule, doesn't it?"

"You mentioned the cost of the power plant, necessary for the operation of either air or electric locomotives. I should think one large central station of sufficient capacity to provide electrical energy for all of the mines controlled by one company in any particular district would be a logical conclusion. But for all that we have found that each colliery has a steam plant of its own."

"Well, that used to be the idea, but in recent years

the operators have come to see that electric energy can be transmitted cheaper than steam or compressed air can be delivered through a pipe. There are a number of coal companies generating all of the power used in their several collieries in a single station. You see the operating expenses are cut way down, for one shift of men in the one power plant will supplant half a dozen or more shifts employed at the smaller plants. All coal is distributed to the one plant, which, with the refuse, can

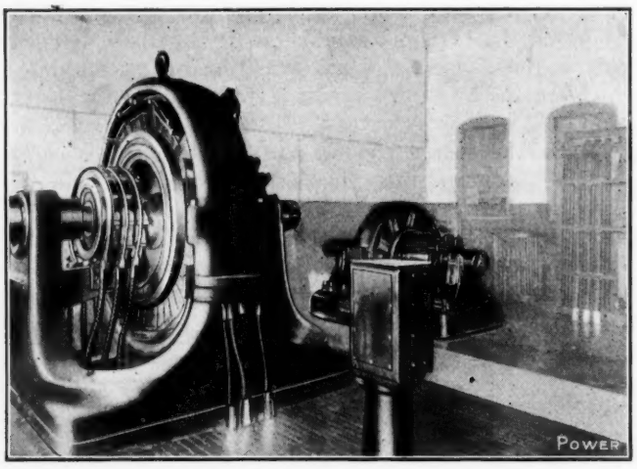


FIG. 5. TWO ROTARY CONVERTERS FOR MINE SERVICE

be handled more cheaply than when distributed among several plants."

"Of course," I said, "it is cheaper to keep large turbines or reciprocating units in proper shape than it is to keep a large number of small units in condition. I suppose the saving would be in excess of the interest charges on the additional investment. How about that?"

"That is right, and the operating expense is further reduced by the apparatus running condensing in most cases of large units. In these large installations alternating current is generally used, but direct current can be generated to good advantage when the distance of transmission does not bring the cost of the copper-transmission wires to a prohibitive point. Now, electrical energy is measured in watts which is the product of the voltage multiplied by the amperes. That is, if the voltage is 250 and a load of 1000 amp. is carried by a line, the line would be carrying 250,000 watts, or 250 kw.; there being 1000 watts in a kilowatt. If the same amperes were carried, but at a voltage of 500, the load on the line would be 500 kw., or just twice that at 250 volts. So long as the amperage remains the same, the voltage can be increased to 1000, 1500 or 2000, or practically any amount and the same wire will carry it.

"It is usual to keep the line drop, or the loss of voltage due to the resistance of the wire, within 5 per cent. for a long line, or 2 or 3 per cent. for a short line. To carry a given load in kilowatts, either the wire must be large enough or the voltage high enough so that, in relation to the current (amperes) carried, the wire capacity will be sufficient to insure a low line drop.

"But you see direct-current motors are not designed to use voltages much above 600, on account of commutator sparking, and the danger the exposed brushes, etc., would be to workmen. For these reasons if voltages higher than 600 to 650 volts are desired alternating current is used, using a motor generator or rotary converter to change the alternating current to direct current for mine use."

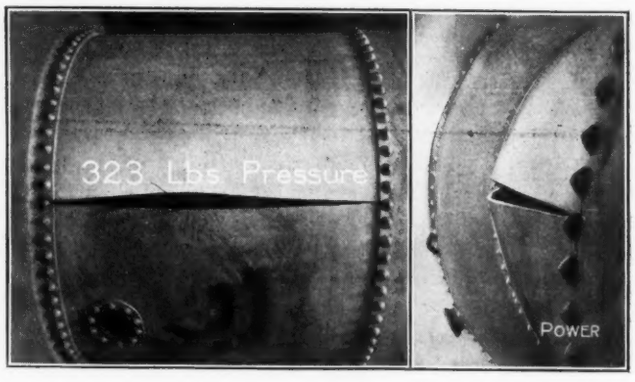
Just then the train drew in at our station and we reluctantly gave up our comfortable seats in the train to jolt over rough stone paving in a swaying bus, which cumbersomely made its way to the hotel. After a good supper we agreed to visit a mine central power plant the next day to see just what kind of equipment was to be found.

Nut Lock

In a nut lock manufactured by Schum Brothers, Metropolitan Tower, New York, N. Y., the nut is provided with internal slots. The bolt is slotted and in the slot is a threaded segment backed up by a helical spring. The end of the bolt is drilled and tapped for a round-head machine screw, which normally holds the threads of the segment in pitch with the threads of the bolt. When the nut is almost down to its seat, the machine screw in the bolt end is slacked back, which permits the threaded segment to be forced by the spring out of pitch with the threads of the bolt when the next internal slot in the nut is in line with the segment. To remove the nut the machine screw is tightened to force the threaded segment again into pitch with the threads on the bolt.—*American Machinist.*

Surprising Results of Boiler Destruction Test

The photographs show the result of a hydrostatic test to destruction of a boiler built 23 years ago which was to be used as an open tank. It was of the following dimensions: The shell, 61 in. in diameter, had 182 fifteen-foot tubes rolled in but not beaded. It was of the three-course, lap-seam, double-riveted construction, having ½-in. shell and tube sheets. The pressure was applied with the idea of showing the weakest part.



UNSUSPECTED FLAW IN A SHEET

It was expected that the tubes would be first to show distress, but when the pressure reached 320 lb. the lower course next to the ogee split as shown. The sheet bulged out about 3 in. The lower tube sheet dished about ⅜ in., while the upper remained perfectly straight, and all the seams and tubes were tight. It was estimated that the shell should withstand at least 600 lb.

Editorials

Fallacy of Cheap Grate Bars

It is surprising that the trade persistently demands cheap grate bars. One would think that those able to appreciate the necessity for good material and workmanship in castings for high-duty pumps, locomotive cylinders and the like, would see the need for such qualities in their grate bars. Nevertheless, when the importance of good grate bars is urged, the usual response is: "Why, they're only grate bars! What's the use—the fire will only burn them up, anyway." It is the old weakness for substituting "something just as good."

The idea seems to be that when a grate bar burns out, any old thing will do just so it will hang together. If the fire is kept from falling out, no attention need be paid to the reduced draft area and the restricted combustion.

Rough appearance and absence of both machine finish and paint deceive the user into thinking that any kind of iron will do to make a grate bar. A superfine quality of foundry iron is not urged, though there are many places where such material is none too good. The iron should be sound, hard, well knit and homogeneous. The long service this kind of bar will give amply repays the extra cost. It is almost criminal to spoil a well designed firing chamber by the use of inferior grate bars when it is so essential that they be properly designed and proportioned.

The bulk of the grate-bar business is in the hands of the small country foundries, which make them of scrap agricultural machinery castings, hard as flint and full of dirt. The fact seems to pass unnoticed that the openings come filled up; that they soon crack and burn, and that their closed vents call for harder firing and more coal.

Flagrant disregard for economy in the operation of the plant causes us to wonder why, in this age of efficiency, so many men persist in standing in their own light in the important matter of grate bars.

Consulting Engineering Gratis

Knowledge and ability are not acquired without hard work and expenditure of time and money.

Besides attending to routine work, most engineers, whether consulting or operating, find it expedient to specialize in certain branches of the art. They become exceptionally well informed in these directions, their friends know of it and tell their friends, and soon a man's reputation for a particular class of work is established.

Unquestionably this is good for the man, but there is a constantly growing tendency to use such men as "good things." To a degree, this practice is not objectionable, for, after all, there is much truth in the question: "What good is a friend if you cannot use him." To this should be added "so long as he is not misused." If one goes to a doctor or a lawyer friend and seeks advice, he is charged for it. Why not? Doctors and lawyers do not become such solely for the salvation or satisfaction of their friends, and neither do engineers.

We know many engineers who, by hard study and costly experimenting, have so informed themselves that they excel in certain directions. Most of them are not consulting engineers, but operating men, who have large plants under their supervision; who are burdened with heavy responsibilities, who must not only direct, plan and foresee in a general way but must devote considerable time and effort to many details, each seemingly insignificant in itself but the cumulative effect of which means much.

These men are busy. Their time is valuable. Their employers do not pay them to spend an hour giving Mr. Jones some information about this, nor for having a fifteen-minute telephone conversation answering Smith's question about that, or for using a stenographer twenty minutes to reply to a letter from Mr. Brown, who wants enlightment on "just this one little point."

If there were but one Jones, Smith or Brown, it would be a pleasure to give the information requested, but when there are many, and the total time consumed amounts to hours each week, then it is time to call a halt.

This situation exists with many men. They are broad, willing fellows, all of them. They are always glad to oblige and never wish to offend, but, when about to use their time to enlighten you on "this one little point," remember that there are many "points" and many who seek enlightenment. You are asking for professional service gratis; unintentionally, unknowingly, misusing a good man and reducing the business of consulting engineering to mere panhandling.

More Foolish "Editation"

In an editorial entitled "More Foolish Legislation," the *Hotel World* protests against passing laws for examining and licensing stationary engineers to handle heating boilers. The remonstrance sparkles with gems like this:

> The explosion of steam-generating boilers, notwithstanding the millions of them in use, is a thing so rare that notwithstanding every such accident is reported in the press, weeks go by without such a report appearing in the prints. It is true that once in a while a locomotive or other high-pressure boiler, carrying from 50 to 200 pounds pressure, explodes. But there is far more danger to humanity from falling street signs than from steam boilers carrying from one to twenty pounds of steam for heating purposes.

As the compilation of accidents to boilers in the last issue shows, there were over five hundred accidents last year that we heard of, and doubtless many more, so that the high-pressure variety go off a little more often than "once in a while," and not many "weeks" went by between any two accidents.

As for the low-pressure boilers being no more dangerous than "falling street signs," we cannot say. We have no statistics of the killed and injured from falling street signs. We can show, however, that last winter there were several serious heating-boiler explosions. We specially commented on some of them and were so impressed with the importance of a contention the very opposite of that of the *Hotel World*, that we directed attention in our is-

sue of May 5, 1914, to the necessity of guarding life and property from heating-boiler explosions.

A little later in the *Hotel World's* editorial, we come to the thing that makes the legislation foolish in the editor's eyes:

> The proposed statute would mean for a hotel, during at least the winter months, when steam heat is demanded night and day without interim, three licensed men for each hotel, for men will not and the law will not now permit men to work 12 hours in 24. The difference between a licensed man controlled by union schedules of wages and common firemen is the difference between $3 to $5 per day per man for three men and $25 to $50 per month for two men.

Taking the worst figures cited, it would cost a hotel $450 a month instead of $25 to $50. Is not that a terrible price to pay for the increased safety of its guests during the winter? If the journal we are criticizing fairly reflects the attitude of its field, the editor of this paper hopes to do all his traveling in the summer, when he can stop at a hotel without feeling that he is sleeping over a gunpowder mine.

Finally, our contemporary knocks all the force out of its argument with this closing sentence:

> No sane or sensible business man objects to inspection or supervision, because some plants should have it, nor does he object to competent employees, but to compel an employer to hire a $150 man to take care of a $50 job, when the danger is as remote as it is in the use of low-pressure boilers, is to work a graft for unionism and, in the last analysis, load an unjust burden on hotel patrons, for they in one way or another must pay the freight in the final equation.

If the hotel patrons have got to "pay the freight" anyhow, what is all the kick about? Perhaps they care enough for their own safety to pay a few cents more a day rather than take chances of being blown through the roof. Who knows?

The Value of Tools

The repair item is more important in determining the actual cost of power turned out by a plant than is generally realized. It is not merely the amount of money spent for repairs as shown by the balance sheet that is important, but what economies are obtained from its expenditure. If such sums are spent judiciously and the desired results achieved, the savings therefrom accrue during every day of subequent operation. Remedying each defect, regardless of size, as soon as it is discovered, does its share toward cutting the power cost.

Broadly speaking, the money for plant upkeep is spent in one of two ways. One is to give the plant a thorough overhauling at definite intervals; meantime no effort is made to do repair work. This generally means dismantling important units, replacing expensive parts, and calling in outside workmen, whose cost in wages and incidental expenses is much greater, man for man, than the cost of the regular employees of the plant. Heavy expenditures for repairs coming in a lump also naturally cause an unfavorable financial showing for the time being. The other method is for the plant's operating force to attack, instantly upon discovery, with such resources as they possess, all defects, great or small. It is a pleasure to any engineer to work with good tools and shape metal into useful devices; it is second nature for him to tinker. Furnish him the means and he immediately begins to think of ways to keep in proper order and to improve the equipment under his charge.

What can be better policy than to utilize this natural desire for handling tools to keep the plant equipment up to maximum efficiency? In every power house there is a quantity of small apparatus which is constantly wearing out and the neglect of which means an unnecessary increase in the cost of operation. Chronic neglect of this minor equipment eventually results in sending for outside aid and in heavy repair bills, which must be paid in a lump. Constant attention to the upkeep of these same small details by a plant force equipped and instructed for the work results in repair bills being reduced to the minimum and spread over such a wide period of time as not to prove burdensome financially.

Some owners of power plants hesitate to invest in a few of the simpler machine tools on the ground that they would be used only occasionally and would not earn the interest on their cost. One thrifty electric-light plant overcame this objection by establishing a tool fund, to which was credited such small miscellaneous revenue as was derived from the sale of scrap metal and similar sources not connected with the company's regular business. Whenever the amount in this fund was sufficient, some useful machine tool was purchased. A blacksmith's forge, drill press, emery wheel, electric drill and a small engine lathe were eventually acquired. Thus in a few years this company had not only a well maintained, smoothly operating plant, but also an auxiliary repair shop, which in itself was a valuable asset.

The effect on a plant's operating force of putting tools into their hands is wonderfully bracing. With the responsibility of the plant's maintenance put up to them, latent energy and ambition are sure to be awakened. That most important element for cutting power costs, the interest of the men themselves, is thus aroused and made of permanent benefit to the plant.

A side light on a central-station failure is the following newspaper report of the conditions at Meridian, Miss., after the explosion of a boiler at the central power plant supplying current to many private consumers besides the street lighting and traction system.

> As a result of the explosion, the city is in darkness, the street cars are standing on the tracks over the city at the places where the current went dead and kerosene lamp and tallow candle are doing duty in the places where there are no gas fixtures. The elevators are standing still, and in several plants automobile engines have been installed to furnish power. Daily papers are being issued under difficulties. The "Star" got out this afternoon half size by using an automobile engine as motive power; the "Morning Dispatch" has had a large gasoline engine installed to pull its press, and motorcycles will pull the battery of type-setting machines.

All the eggs seem to have been entrusted to one basket.

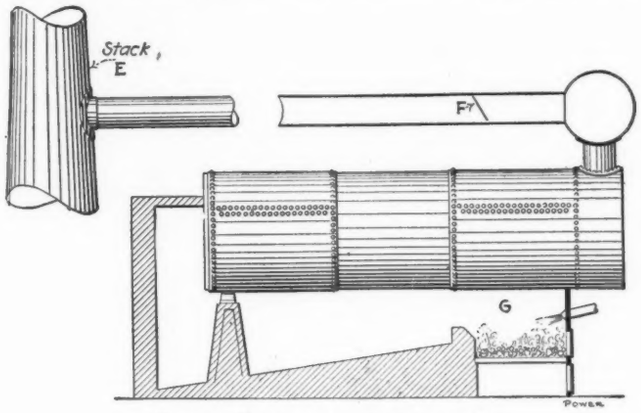
The number of instances in which convex boiler heads have failed at the heel of the flange has been sufficient to indicate, at least, that there is something radically wrong with the generally accepted formula for figuring the strength of such heads. In the present issue, Mr. Gasche makes a very complete analysis of the stresses in this region of the head and his deductions show that a much higher factor of safety is demanded than it has been customary to allow. A careful perusal of Mr. Gasche's article is recommended to all interested in the manufacture or operation of steam boilers.

Copies of the index to POWER for the first six months of 1914 (Vol. 39) will be ready for distribution in about two weeks and will be sent without charge to subscribers requesting them.

Correspondence

A Boiler Test

In a recent boiler test steam jets were used as a basis of smoke prevention. These jets were placed above the grate, as shown in the illustration, and were of the inductive type—that is, they carried in a volume of air with the steam. They had valves for individual control, and were so arranged that they could be entirely cut off. One trial of a day's duration was run, with steam jets, and one without, and an exact measure of water and coal



DRAFT TESTED AT E, F AND G

was noted in each trial. The results are shown in the accompanying table.

	With Blower	Without Blower
Duration of test, hr	9	9
Steam pressure, lb.	96.5	97.07
Feed water, deg. F.	139.3	139.67
Total feed water, lb.	40,091.0	35,481.5
Total coal, lb.	4,860	4,440
Moisture in coal, per cent.	2.06	2.06
Coal, B.t.u.	13,840	13,840
Coal, per sq.ft. grate, lb.	11.87	10.85
Evaporation of, lb.	8.25	7.99+
Draft at E, in.	0.66	0.66
Draft at F, in.	0.42	0.30
Draft at G, in.	0.17	0.22
Flue gas temperature, deg. F.	434.25	398.5
Room temperature, deg. F.	83.00	89.00
Per gas analysis CO_2	9.36	8.76
Per gas analysis O	9.12	10.93
Per gas analysis CO	0.33	0.25
Per gas analysis N	81.19	80.03
Boiler hp. rating	155	155
Boiler hp. developed	144	127.25

While the test shows a slight gain by the use of the steam jets, I should say it was mostly due to the change of draft conditions during firing when the coal was generating its greatest and was quickly burning the gases, which in turn would naturally obviate smoke. Note the change of velocity of the moving gases at the point *F* in the stack connection. This would be largely responsible for such bettered conditions, as it is not always well to have an increased furnace draft.

Frequently, we have boiler trials that show too much grate-surface draft, while the increased temperature of flue gases would tend to increase the draft at the point *F* and above. On the other hand, the tests run without steam jets were made with a less horsepower; consequently there was a lower gas velocity, due to the stack-base temperature.

I should not take this test seriously in behalf of the use of steam jets at this point for smoke abatement. While this did run a cleaner stack top, we would naturally look for this from the conditions set forth. Still this test is of interest to the power-plant operator, notwithstanding the gain is only 31 lb. of coal to the 1000 lb. burned.

C. R. MCGAHEY.

Baltimore, Md.

Cost of Operating a Vacuum Ash-Handling System

In the April 7 issue, there is an article describing a vacuum ash-handling system, with some figures on the cost of operation which are probably correct so far as they go, but they give no idea of the total cost of handling a ton of ashes. The item—5.29c. per ton—covers the cost of steam only, which is but a small part of the total cost, as can be readily shown.

Let us assume a plant of four 400-hp. boilers, three of which are in constant operation at their rated capacities. With a boiler horsepower on 5 lb. of coal and the ash content of the coal 12 per cent., we would have

$$1200 \times 5 \times 0.12 = 720 \text{ } lb.$$

of ashes per hour. Assuming the plant has ash hoppers with capacity sufficient for a day's operation, we would have

$$\frac{720 \times 24}{2000} = 8.64 \text{ } \textit{tons of ashes per day}$$

According to the reported test, seven tons of ashes were handled in an hour. This would require the services of two men to feed the ashes into the pipe—rapid work being necessary to prevent a waste of steam. With two men at 20c. an hour and working at the above rate, the labor charge per ton of ashes is

$$\frac{2 \times 20}{7} = 5.71 \text{ } \textit{cents}$$

For a plant of this size, the apparatus completely installed would probably cost $1800, say, $1000 for the tank and $800 for the piping. With 6 per cent. interest on an investment of $1800, this charge against a ton of ashes is

$$\frac{1800 \times 0.06 \times 100}{365 \times 8.64} = 3.42 \text{ } \textit{cents}$$

The depreciation of the ash tank is at least 8 per cent. On an unlined tank it would be more, because of the corrosive action of the wet ashes. In either case, the baffle-plate would require frequent renewal. The depreciation of the ash pipe is high—fully 40 per cent. The effect of ashes striking a bend in the piping while traveling at a high velocity can be appreciated only by those who have had experience with such things. At the above rates, the depreciation charge per ton of ashes is

$$\frac{1000 \times 0.08 + 800 \times 0.40}{365 \times 8.64} = \$0.1268 \textit{ or } 12.68 \textit{ cents}$$

Adding the foregoing, we have

$$5.29 + 5.71 + 3.42 + 12.68 = 27.10 \textit{ cents}$$

as the cost of handling a ton of ashes.

To dispel any suspicion that the assumptions made are unwarrented, I will say that I had some experience with a vacuum ash-handling system in which the vacuum was maintained by a so called "positive blower" which was driven by a back-geared 50-hp. motor. The average life of the manganese-steel wearing backs (2½ in. thick) at the bends was 11 days. These wearing backs were replaced by plugged tees, but the power required to operate was such that the 50- was replaced by a 75-hp. motor. The cost of handling a ton of ashes at this plant was 26c., exclusive of fixed charges. The system was abandoned for a mine car and skip hoist.

Gebhardt's "Steam Power-Plant Engineering" describes a vacuum ash-handling system like the one just referred to. It winds up with the statement that "the cost of handling the ashes in this installation is approximately 7c. per ton." Now, anyone working up the data given will find that the 7c. would no more than cover the cost of power, and does not include labor, maintenance or fixed charges.

It seems to me that plants are exceptional where a vacuum ash-handling system is indicated, and that it cannot successfully compete with handling with wheelbarrows where the length of travel is moderate.

I'll confess that it is a pretty thing to see ashes disappearing through a hole into a pipe, the ashes ending their journey in a tank placed over a railroad track, but the novelty soon wears off when the operating costs become known.

C. O. Sandstrom.

Kansas City, Mo.

Thermocouple Connection

In the April 21 issue an article entitled "Gas Producer Testing," referring to gas temperatures, contains the statement, "To make corrections for the increased resistance, due to the heating of the cold junction of the thermocouple above its calibrated zero mark, a mercury thermometer should be so suspended that its bulb will rest on the junction, thus showing to how much this heating amounts." This statement becomes misleading when the principle of the thermocouple is explained. A thermocouple has two wires of different composition; say, for instance, one of copper and one of iron. These are joined at one end, which is inserted into the furnace and called the hot junction, the two free ends being connected either directly to the reading instrument or to copper leads which run to the reading instrument.

The point where these ends outside of the furnace connect, either to the instrument or to the copper leads, is called the cold junction, and it is the difference in temperature between the hot and cold junctions which is the source of electrical energy. If the hot and cold junctions were at the same temperatures, there would be no electrical energy developed and, hence, no indications would be shown on the reading instrument as there would be no temperature difference between the two junctions.

In commercial practice, the cold junction temperature of the thermocouple is assumed to be around 70 to 100 deg. F., which is average room temperature, and the zero mark on the reading instrument is from 70 to 100 degrees.

Should an instrument be set with a zero mark of 100 degrees and the actual temperature at the cold junction be about 200 degrees, it would read low by approximately 100 degrees, depending upon the characteristics of the thermocouple. This applies to most base metal thermocouples; with a platinum thermocouple, the reading would be low by approximately 40 or 50 degrees. Therefore, the statement is misleading that corrections should be made for "increased resistance due to the heating of the cold junction."

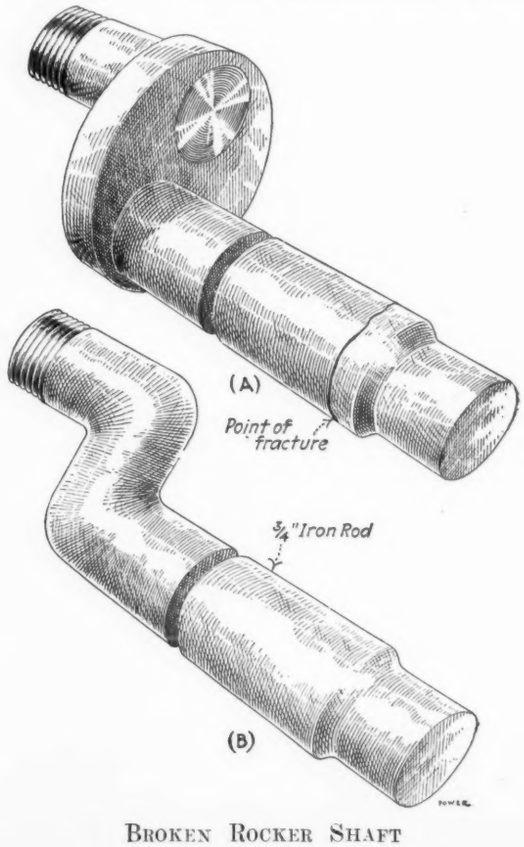
Where platinum and platinum rhodium or "rare" metal couples are employed, the resistance so increases with the temperature that the current generated is cut down and, should the resistance of the indicating instrument be nearly that of the couple, a serious error would result. The only practical method of overcoming this is to use a reading instrument of high resistance so that slight changes in the resistance of the thermocouple and wiring will be negligible.

Joseph C. Schwarz.

Rochester, N. Y.

Emergency Repair to a Duplex Pump

Because of a defect in the material, one of the rock shafts on our duplex pump broke close to the valve-motion lever, as shown at *A*. As it was necessary that the pump be kept running, a piece of ¾-in. iron rod was hastily bent in the shape indicated at *B*, dressed



Broken Rocker Shaft

up with a file, and after threading one end for the nut it was put in place of the broken shaft. The pump ran satisfactorily until a new shaft was secured.

ERNEST A. TICHENOR.

Beechwood, W. Va.

Selecting a Pump

In the May 12 issue, Mr. Webster is quite correct in believing that the lowest-priced article is not always the cheapest, and if he had carried his investigation still further, he probably would have chosen a more suitable installation.

A horizontal centrifugal pump, where there is a suction lift, is seldom the best pump. It requires a foot valve which is usually hard to maintain tight, especially when using river water with its attendant sand and other solid matter. When the pump is at a distance, as in Mr. Webster's case, the time spent going to the pump to stop the leakage of the foot valve and consequent loss of priming is a serious item. If no check valve were placed in the discharge line, the pump would always be primed, but the loss of water might be serious since there would be no way to tell just how great the leakage through the foot valve might be.

A better installation is a vertical submerged pump placed in a small concrete pit at the river side, with the suction line running through the pit wall or over the top of the pit into the river. Eliminating the foot valve and placing a check in the discharge line would prevent the water in the tank from running back through the pump. Even with a 7-in. pump, the extra cost of the vertical type should not exceed $100 plus the cost of the concrete pit.

Mr. Webster states that the maximum demand does not exceed 675 gal. per min. Since the triplex pump furnishes 268 gal., the centrifugal pump has but 407 gal. per min. to furnish. Furthermore, it appears that the total hourly water consumption is such that the centrifugal pump is in operation five times an hour for periods of 4½ min. each, or a total of six hours per day.

Pump D, the one chosen, requires 19.63 hp. per hour, or the daily power required for the six hours of operation is

$$\frac{19.63 \times 746 \times 6}{1000} = 87.86 \textit{ theoretical kw.-hr.}$$

A squirrel-cage motor of this size would have an efficiency of about 85 per cent., so the actual power required to pump the water would be

$$\frac{87.86 \times 100}{85} = 103.4 \textit{ kw.-hr.}$$

However, there is a serious loss that occurs in this method of pumping that must be considered.

Each time the motor starts it requires about three times the running current to bring it up to speed; this demand lasting for about 15 sec. Consequently, the power required to start the motor five times an hour, or 80 times a day, would be

$$\frac{19.63 \times 746 \times 100 \times 3 \times 15 \times 80}{1000 \times 85 \times 60 \times 60} = 17.2 \textit{ kw.-hr.}$$

The transformer loss would average about 3 per cent. for both the active and the idle periods during the 24 hr., or, using a transformer capacity of 20 kw., the loss would be

$$\frac{20 \times 24 \times 3}{100} = 14.4 \textit{ kw.-hr.}$$

Then the total power required for the pump would be

$$103.4 + 17.2 + 14.4 = 135 \textit{ kw.-hr. per day}$$

A better solution would have been to use a pump which by continuous operation each hour would, together with the triplex pump, supply the hourly consumption. The 7-in. pump now delivers 15,750 gal. per hour, so a 2½-in. pump delivering 275 gal. per min. would be able to meet the hourly demand.

Of course, it is possible that the demand is a varying one and that the amount and period of demand coincide with the capacity and running period of the 7-in. pump, namely, 700 gal. for 4½ min. However, the elevated tank need hold only 4100 gal. to handle all the water delivered by the triplex pump and the 2½-in. centrifugal pump during the 7½ min. when the factory demand is zero. If the demand at night is light, then the small pump could be handled by automatic control, as is the 7-in. pump at present.

Figuring the total days pumping from the present operation, then the 2½-in. pump need run 16 hr. per day, made up probably of 12 hr. continuous operation and 4 hr. intermittent pumping of eight 30-min. periods. Using the same discharge line as at present, the friction loss would be so decreased that the total head would approximate 75 ft. instead of 80 ft. as at present.

It is possible to obtain a 2½-in. pump with an efficiency of 65 per cent., while a motor of the required size should approximate 85 per cent. The power requirement would figure as follows:

$$\textit{pumping} = \frac{5.2 \textit{ hp.} \times 100 \times 746 \times 100}{65 \times 1000 \times 85} = 7 \textit{ kw. per hr.}$$

$$7 \times 16 = 112 \textit{ kw.-hr.}$$

$$\textit{starting power} = \frac{7 \times 3 \times 15 \times 8}{60 \times 60} = 0.7 \textit{ kw.-hr.}$$

$$\textit{transformer loss} = \frac{7.5 \times 24 \times 3}{100} = 5.4 \textit{ kw.-hr.}$$

Total power required equals

$$112 + 0.7 + 5.4 = 118.1 \textit{ kw.-hr.}$$

The saving over using the 7-in. pump would be

$$135 - 118.1 = 16.9 \textit{ kw.-hr. per day}$$

or

$$16.9 \times 300 = 5070 \textit{ kw.-hr. per year}$$

which, figured at 2½c. per kilowatt-hour, is $126.75 per year.

L. HARVEY.

Waco, Texas.

Hints on Starting a Compression Plant

William L. Keil's article, in the June 2 issue, on this subject deserves criticism, as some of his statements are misleading. He states that there are many types of refrigerating machines, some with "oil system," others without; those without he calls "dry systems."

By oil system I infer that Mr. Keil means the oil injection as used in the De La Vergne type of refrigerating machine. This injection has two purposes, to fill the clearance spaces in the compressor and to cool it. The latter is a strictly dry-gas machine.

Ammonia compressors not using the oil injection are not all dry systems or dry-gas machines, as Mr. Keil

would have us believe. There are two systems of running ammonia compressors, the wet and the dry.

In the wet system the ammonia gas returning from the evaporator is in a wet or saturated condition. Therefore its name, "wet compression." In this system the frost line is carried back to the machine; in fact, the suction parts of the compressor should be well frosted. No water is used in the jacket with this type of compressor as the cold and saturated condition of the ammonia vapor returning to the compressor will keep it sufficiently cool without the aid of jacket water.

In the dry-compression system the frost line is carried up to within 5 or 10 ft. of the suction valves; hence the returning ammonia gas is dry or slightly superheated. In this system of ammonia compression a water jacket and water circulation through the compressor is necessary to carry off the heat due to compression.

There has been much dispute among refrigerating engineers as to the relative merits of these systems. Nearly all ammonia compressors are fitted with water jackets so that they can be run either dry or wet.

"In starting up, see that the equalizing valves are open," states Mr. Keil. In my experience I have found few compressors excepting motor-driven ones that have had equalizing valves between the suction and discharge sides of the compressor. Hence, Mr. Keil's statement applies only to a few compressors.

Mr. Keil states that the water should not be turned on the condenser until the pressure has risen to the working pressure usually carried. This, in my opinion, is bad practice. It is far better to turn the water on the condenser as soon as the compressor is started, or a little before, as the lower the condenser pressure—to a certain point of liquefaction—can be held, the more economically and efficiently the machine can be run, as the lower the condenser pressure, the more gas the machine can handle per revolution.

If the condenser be allowed to run without any water until the desired working pressure is reached, it is quite evident that the condenser is warm, if not hot, and turning cool water suddenly on a hot condenser is not good engineering practice. The sudden cooling effect of the water on the hot condenser is liable to start a series of leaks due to the sudden contraction of the pipes and joints on the condenser. These leaks are sometimes hard to find and most troublesome to repair.

It is far better, in my opinion, to turn the water on the condenser before starting the compressor so that the condenser and compressor will heat up slowly and evenly to the temperature of the working pressure.

As to the statement about direct and indirect systems of refrigeration, I have found that the direct system is more extensively used in smaller plants and hotels than is the indirect system. The direct system of expansion eliminates brine pumps, brine tanks, agitators and a lot of piping, which makes it a favorite over the indirect or brine system.

A little further on Mr. Keil states that the brine should never be lower in density than 79 deg. or higher than 90 deg. Bé. This statement is erroneous, as 90 deg. Bé. would mean a solution of approximately 80 per cent. salt and 20 per cent. water, which is almost a solid mass. I believe Mr. Keil means 70 to 90 deg. on the salometer instead of the Baumé scale. Seventy-two degrees on the salometer scale at 64 deg. F. is equal to 18 deg. on the Baumé scale and the specific gravity is 1.140, while 92 deg. on the salometer at a temperature of 64 deg. F. is equal to 23 deg. on the Baumé scale and the corresponding specific gravity is 1.186.

Calcium brine with a specific gravity of 1.186, or 23 deg. Baumé., can be cooled to 5 deg. below zero without any danger of freezing.

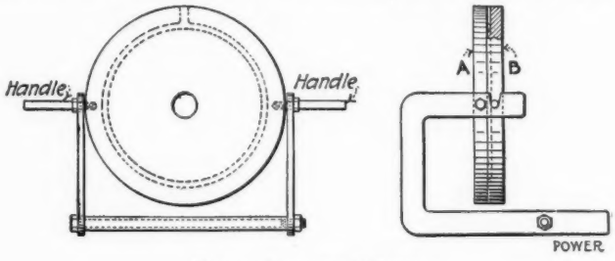
C. E. Anderson.

Chicago, Ill.

Lead Boiler Gaskets

The article on this subject, by J. C. Hawkins, in the Apr. 28 issue, was interesting. I have seen lead gaskets used in several plants and they have been entirely satisfactory.

The illustration shows the simplest and most convenient mold that I have seen. Plate *A* is flat and bolted to a stand made of two strips of wrought iron bent as shown. Plate *B* has a groove for the desired size of gasket. The two handles serve another purpose by fitting into the beveled slots in the stand and holding plate *B* firmly against plate *A*. This is handier than dowel pins and capscrews. When more than one size of gasket is needed, another plate, like *B*, is made with the desired size of groove.



Lead-Gasket Mold

Lawrence Kjerulff.

Kansas City, Mo.

Preheating Furnace Air

A great deal has been published lately in Power about boiler-room economy, but I have seen nothing like my system.

We had considerable hot water (condensate) of 200 deg. and over that we did not know what to do with except let it cool in a large tank; this seems to be general practice. I reasoned that if a few degrees difference in the feed water made a saving, then a few degrees difference in the air under the grates should make a saving also.

I cleaned out behind the bridge-wall and put in a lot of old pipe coils, making a large radiator; then I connected it to a pump to get a circulation of the hot water through the coils. By roofing this over and making some holes through the bridge-wall below the grates and one large one in the side of the setting, we had it fixed so that all of the air for draft had to pass over those coils, when the front ashpit doors were kept closed.

We have no way of determining the amount of saving, but by measuring the coal I am convinced that at least 15 per cent., and possibly more, was saved.

M. A. Olmstead.

Sterling, Kan.

The Horsepower of a Rainstorm

Recently, there was a severe rainstorm in this locality, and when talking to an engineer about it afterward, the question of its horsepower arose. I was interested enough to hunt up data on which to base a calculation.

The rainfall amounted to 4.17 in. in 10 hr. over a surface of approximately 10 square miles, and the estimated average height of the rain cloud was 5000 ft. This represents approximately 6,000,000,000 lb. of water which had fallen during 10 hr. from an elevation of 5000 ft., or 15,000,000 hp.-hr. Thus we see the energy represented by this one short storm.

Suppose man could avail himself of this energy and store it so it could be used at pleasure; for instance, for lighting city streets with 4000 arc lamps. Allow 500 watts per lamp, making 2000-kw. load during the lighting period equal to 2680 hp. or, including losses, say, 3000 hp. Allowing 12 hr. in 24 as the lighting period, the daily load will amount to 36,000 hp.-hr.

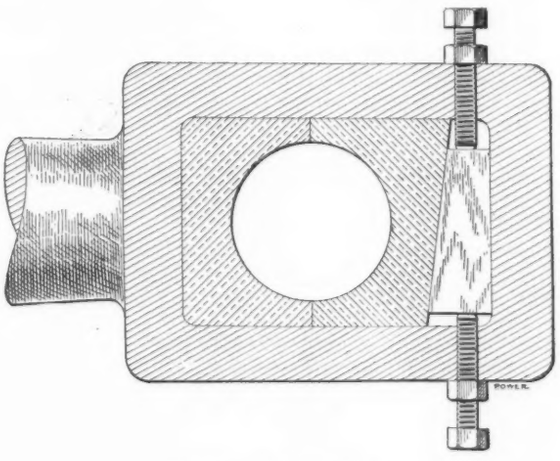
The length of time this energy would last would be 425 days, or one year and two months of light from one storm. This gives some idea of the enormous energy at work in nature.

G. P. Pearce.

Moline, Ill.

Allowance for Expansion

I knew that brass expanded more than iron, but in this case I was caught. As shown in the illustration, it was a solid connecting-rod end for the crankpin of a fairly large horizontal engine. As there was a slight knock I stripped the brasses to what were my ideas of a nicely running fit. I was told by the engineer that it had a



Type of Stub-End

habit of heating up quickly and that previous engineers had tried to tighten it.

It went nicely for about one hour when there was not much load. Thinking it was all right, I went to some other work, but the engineer soon said it was heating and he would have to stop. The heat was not great, but the engine was being slowed down by the crankpin being gripped. It only took a few minutes to ease the adjusting screws and start the engine. I then reasoned that as the connecting-rod was heavy and solid, when the crankpin and brass heated, the brass was forced to expand on to the pin, so that to escape a stop if there was a chance of the journal heating it would be necessary to allow for the expansion of the pin and brass. On other rod ends where the brasses expand away from the pin, the joint surfaces of the brass being fairly large, the bolts will yield slightly and do not pull up the engine so quickly. After a few weeks I had it adjusted to the original position in which it had seized and it ran all right. This experience may save someone trouble, and reasoning it out afterward.

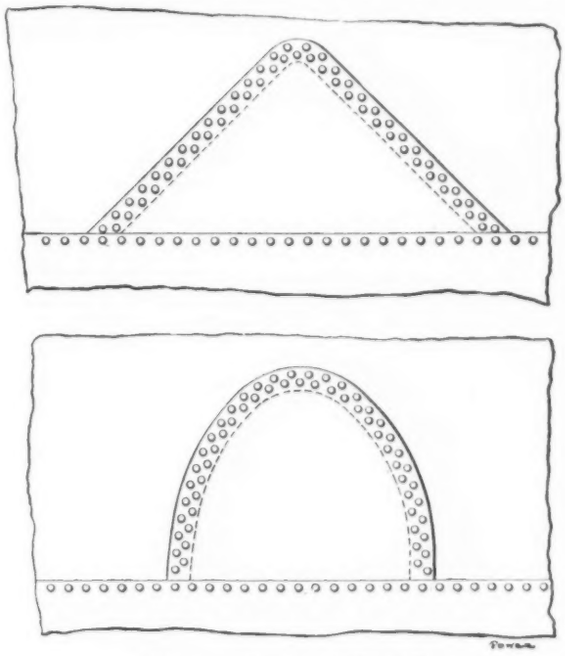
W. Burns.

Govan, Scotland.

Patching Boilers

Some time ago I was asked this question, though I was not perfectly sure of the answer:

"If you had a horizontal tubular boiler constructed according to the Massachusetts rules, with a quadruple-riveted butt joint having an efficiency of 94 per cent., and



Which Form Is Best?

a bag should form on the bottom of the fire sheet 30 in. long (lengthwise of the boiler) by 20 in. wide, beginning at the girth seam, how would you put on a patch, and have the boiler as strong as before?"

My answer was that I should make the patch triangular in shape with the point well rounded, and use a double row of rivets on the sides of the patch with a single row in the girth seam if originally it was single riveted. I have failed to find any formula that would apply to this kind of joint.

If the patch is made square, as it usually is, the lap-riveted, longitudinal sides would be of lower efficiency than the longitudinal seam of the boiler, and as the girth seam usually has a higher efficiency than the longitudinal seam I reasoned that a joint of triangular shape would have a higher efficiency than one of the usual shape.

I have never seen a patch put on in this manner, and perhaps there is some good reason for its not being done. I would be pleased to read the views of other engineers

on its feasibility, and get a suitable formula for laying out the patch, spacing the rivets, etc.

J. C. HAWKINS.

Hyattsville, Md.

Superheaters Flooded

Superheaters in use at the present time in central stations are standard as a rule; consequently the following can be applied:

These superheaters are flooded or filled with water previous to lighting the fire. When the pressure reaches approximately two-thirds that carried on the line, the water is blown out so as not to have water in the path of the steam when the boiler is cut in.

In practice there should be no moisture in the steam after it leaves the superheater, but sometimes a tremendous amount of water will be thrown into the steam line and it is at times quite a difficult matter to determine where it is coming from. Frequently it is leakage at the flooding valve, where a slight leak will not be noticed if the boiler is being fired at anything near its rating. Where a boiler has been banked over a period of several hours and is then fired up quickly, the leak will have partly filled the superheater and be thrown into the line. Therefore, there should always be placed a small valve just in front of the superheater blowoff. Then before firing up or replenishing the banks, this valve should be opened to the atmosphere and if water is present it can be blown out before the bank is disturbed. This bleeder can be bypassed to a trap, but it should always have an open connection for observation. If the flooding valve is kept tight there would be no use for the foregoing, but it is handy to inspect the condition of the flooding valves. Nickel seat and disk valves for use on the superheaters give the least trouble.

JOHN F. HURST.

Louisville, Ky.

Wrong Stator Connection

The synchronous speed of an induction motor depends upon the frequency of the circuit from which it operates and upon the number of poles on the stator. A motor designed to give rated speed on a 50-cycle circuit will run above normal speed on a 60- and below normal speed on a 40-cycle circuit. Increasing the number of poles will decrease the speed obtainable from a given frequency, and decreasing the number of poles will increase the speed obtainable from that same frequency. The stators of all modern induction motors are wound with formed coils, and a change in the number of poles ordinarily calls for change in the pitch; hence, in the dimensions of the coils. That this point may be overlooked is illustrated by the following incident, due in a measure to the fact that the same frame may be wound for two or more pole arrangements.

A four-pole, 60-cycle induction motor was struck by lightning and had to be rewound. The rotor, which had been operating for two years, had been running at a speed of 1800 r.p.m., which was correct for the work that it had to do. After its return from the repair shop, the motor was unable to turn out the work that it did formerly, and on measuring the speed it was found to be only about 1200 r.p.m. As nothing had been handled except the stator, it was suspected, and the difference of exactly 600 r.p.m. was suggestive. Investigation revealed that in connecting the stator it had been connected to give six poles instead of four. On reconnecting for four poles, the original speed was restored.

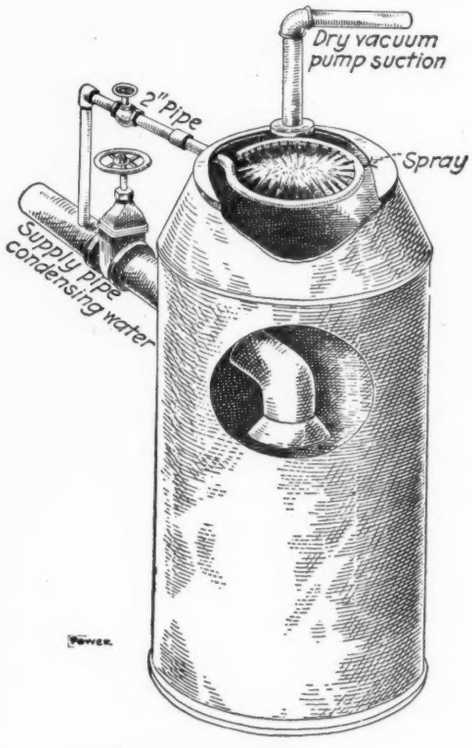
J. A. HORTON.

Schenectady, N. Y.

Increasing the Capacity of a Vacuum Pump

The efficiency of a dry-vacuum pump on a jet condenser can be increased greatly by cooling the air or vapor before it enters the pump.

To obtain this result some makers expose the air outlet as much as possible to the cooling effects of the entering water. Where the water supply is limited, however,



AIR-COOLING SPRAY

and the amount used is reduced as the load decreases, the pump must handle considerable steam or hot vapor due to poor distribution. This does not occur under full-load conditions. An air cooler can be installed consisting of a ring made of 2-in. pipe with 1/8-in. holes drilled upon 1/2-in. centers on the inner diameter, which will suffice for air outlets up to 16 in. in diameter. All of the air or vapor must then pass through the spray which will reduce its temperature and volume.

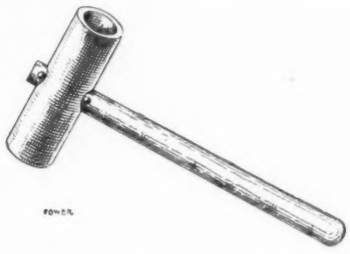
The water used should come from the injection supply and outside of the injection valve. There need be no fear of water being lifted and carried to the pump as the velocity of the air under conditions of high vacuum is very low; therefore the spray water will fall into the condenser. Such a spray could not, of course, be used on surface condensers.

JOHN F. HURST.

Louisville, Ky.

Hammer Made of Steam Hose

When trying to drive back a large dent in a sheet-metal oil tank or filter with an ordinary hammer usually a number of small dents results. To overcome this difficulty, use a hammer made of a short length of heavy steam hose, as shown.



HAMMER MADE OF HOSE

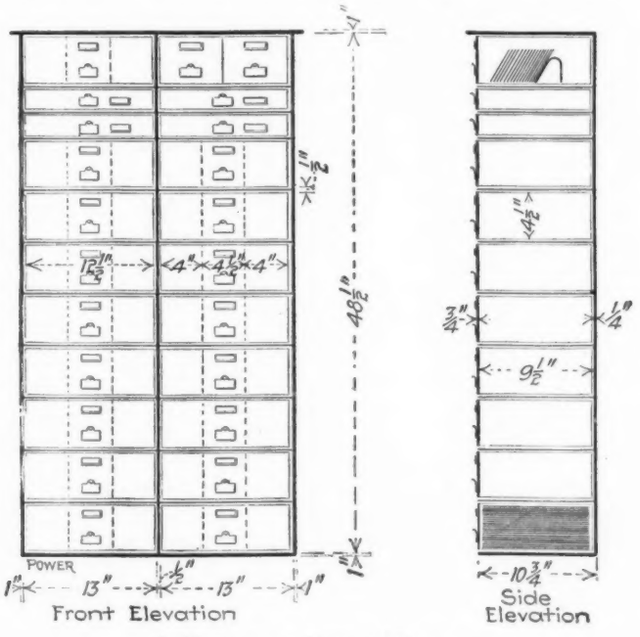
CHARLES FENWICK.

Humboldt, Sask., Can.

Filing Magazines

It puzzled me to find a good and inexpensive way of indexing and arranging my engineering journals. I tried binding them, but the volumes were too cumbersome to take to the plant or to read on the street cars, and sometimes a fellow engineer wanted an article on a certain subject.

I solved the problem in the following manner: I made a cabinet, a front and side view of which is shown. It is 50½ in. high, 28½ in. wide and 10¾ in. deep. The



A MAGAZINE FILING CABINET

sides, top, bottom and front are made of one-inch boards, the back and drawer bodies of one-quarter inch; the partition of one-half inch. It was then painted and the pulls and label holders attached. It contains 16 drawers 9½x12½ in. and 4¼ in. deep inside measurements. Each drawer will hold one year's issues of POWER with the advertisements removed, each issue being loose.

At the back of the drawers an opening of 4½ in. wide was made as shown by the dotted lines, so that the journals can be easily removed. I put a strip of heavy paper between the first and second half year for convenience.

There are four drawers 1¾ in. deep for clippings on selected subjects. Two of the top drawers are used for index cards, which are 6 in. wide, 9½ in. long and 3¼ in. deep. The other is for the yearly magazine index. This cabinet was made during my spare time and the material cost about $5.

When I have several issues on hand, I remove the advertisements and clinch the wire staples. Then I mark the articles and card index them under suitable headings, so that I can find them (sometimes I index them under more than one heading) and then I mark the front page with a capital *I*, so I will know that it has been indexed. I use the index on the inside of the front cover as I find that it explains the contents of the article in a brief way. I abbreviate as much as possible and keep a list of the abbreviations used. For instance *P* stands for POWER and also page; "ill.," illustrated; "col.," column; "E. N.," *Engineering News*, etc. I also index interesting articles in books.

It is most satisfactory to have a place for magazines and the interesting articles indexed so that they may be easily found and can be carried around conveniently.

K. J. LAWRENCE.

Kansas City, Mo.

Centrifugal Pump Would Not Pump

At least 50 per cent. of the trouble with centrifugal pumps results from faulty suction conditions. The following problem illustrates one of the cases where the blame was placed on the pump, whereas it belonged to the method of piping.

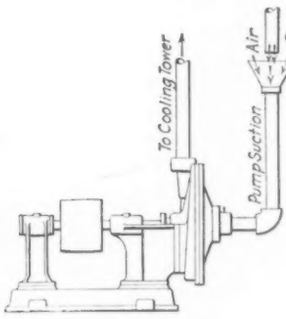


FIG. 1.

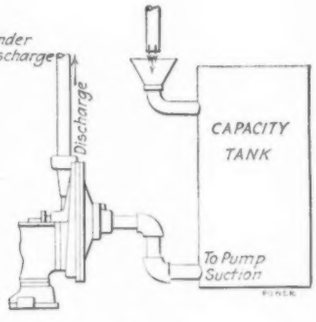


FIG. 2.

Water from the city mains had been used to cool the cylinder of a machine-shop gas engine. The cooling water required, some two thousand gallons per hour, had always accounted for excessive water bills. A refrigerating engineer suggested using the water over and over by putting up a cooling tower on the roof of the shop. The result was the installation of the belt-connected outfit, Fig. 1.

The water from the cylinder jacket had always been discharged to a funnel and piped to the city sewer. A tee was put in and connections made so as to discharge this water direct to the pump suction. It was desired

to keep the open connection so as to know that water was flowing at all times.

Everything completed, the pump was started. The funnel overflowed but no water was discharged from the pump. A larger driving pulley was used to speed up the outfit, but still no results. After some studying the suction was connected to a barrel which it rapidly pumped dry. Connections were then made, as shown in Fig. 2, the pulley size was reduced to the original, and water was easily handled by the pump.

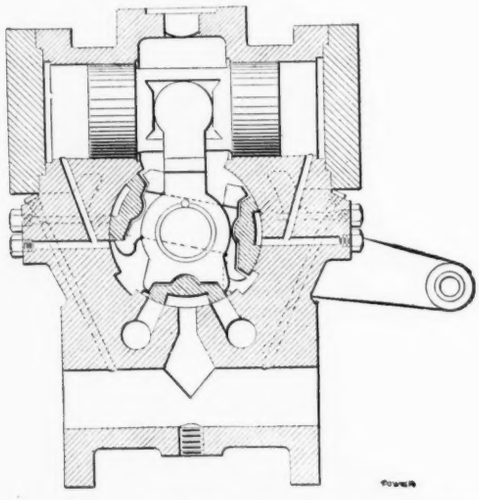
The trouble was evidently caused by air being drawn into the funnel and trapped in the impeller. This air once trapped was not thrown out fast enough to permit the impeller to get a grip on the incoming water, which was also full of air. With the plan, shown in Fig. 2, the air bubbles came to the top of the tank, while water, free from bubbles flowed to the pump impeller, forcing out any air that may have been trapped. The pump has a slightly greater discharge than that of the engine cylinder and so drains the tank. It then runs idle until water rises and flows to the impeller.

H. C. WIGHT.

Philadelphia, Penn.

Emergency Repairs at Sea

By a series of coincidences the same type of accident happened on two large mail steamships on the same design of feed pump which had been recently installed. This was the breaking of the valve spindle, a rod 2⅛ in. in diameter made of mild steel. The spindle has an oscillating movement of about one-quarter turn and receives its motion from a balanced lever, which is actuated by a tappet rod connected loosely to the crosshead of the piston and bucket rods.



As may be seen in the illustration, the valve operated by this 2⅛-in. spindle is only to start the motion of the main valve and open the steam ports, by which the main valve receives the steam that actually gives it motion. Thus the torsion stress on the spindle is slight and when under full steam the gear can be operated by hand.

The first accident, as were also the others, was a scarf break just behind the rocking lever. The spindle was taken out and the pieces carefully held together in a vise, while a ¾-in. hole was bored through with an ordinary ratchet brace.

One-half of the hole was left clearance size and the other tapping size, so that when a tap bolt was screwed in tightly the pieces were brought together and held securely. This done, the spindle was replaced in its position on the pump and a split clip with holes, similar to those in the stem, top and bottom, was clamped over the fracture. The top bolt was screwed through the clamp and spindle and drawn up tightly. Then the clamp bolts were tightened up and the projecting threads of the bolts burred over to prevent slacking back on the nuts as there was not sufficient space to allow locknuts to be used. Then the dismantled part was replaced and the pump restarted in a little over two hours after the breakdown.

While this repair carried the ship to port, the bending stress loosened the arrangement so that it was just a question of time before another repair would have to be effected. A new spindle was fitted, and three months later the same trouble was experienced when only two days from port and five days steaming ahead of us, so that a more substantial job would have to be done if the pump was to be kept working for that period.

On this occasion, the hole was bored as on the previous repair, but instead of the split clip an old nut was filed out $\frac{1}{32}$ in. less in diameter than the stem. Then the holes in the spindle were slightly countersunk so that on riveting the ends of the tap bolt they would not project beyond the circumference of the stem. The tap bolt was screwed home and the ends cut off, leaving sufficient to fill the countersink on the stem, riveted over and filed up smooth to the spindle's periphery. This was necessary as the spindle had to be passed through a neck bush and gland to get it back in working position.

When in place, the nut filed out was made white hot and shrunk on over the break and tap bolt. When cold this made the repair quite solid, and it held until the home port was reached, when a new stem of slightly larger diameter was fitted and no further fractures have occurred on that particular pump.

These two accidents were quickly followed by two similar ones on a sister ship, and as different engineers were in charge different ideas of repairing the break were evolved. The broken parts were sawed off and a square filed in the rocking lever. Then a ¾-in. tapping hole was bored in the center of the spindle parallel to its axis, the spindle replaced in the pump and connected up to the rocking lever. A tap bolt and washer held the lever securely on the squared end of the spindle.

This arrangement shortened the spindle considerably and took the center line of the rocking lever away from the center line of the tappet rod, which was of forked design with a pin through the fork and lever. To connect this up a piece of pipe was cut to fill the inside of the fork and a long bolt passed through the rocking lever, with a bit of pipe as a distance piece, then through the eye of the fork of the tappet rod and screwed up hard with a nut on both sides of the fork, so that the lever was free to move while the bolt was held fast.

This method resulted in the square being wrenched off through a flaw in the material. Another square was filed as large as possible and as this further shortening of the stem brought the boss of the lever up against the gland nuts, they were cut off flush with the gland, which was held in place by the lever boss. Then the bolt to connect to the tappet rod was lengthened. The job with-

stood three weeks' wear and tear, when port was reached and the spare spindle from ashore was fitted and the pump given an overhauling.

C. G. BENNIE.

Itchen, England.

Steam Jets

Steam jets are often employed to increase the draft or to keep the grate bars from burning. From the writer's point of view, this principle seems entirely wrong. The amount of steam used may be found by Napier's rule; that is, the weight of steam a jet will pass in pounds per second when discharging into the atmosphere. Following is the formula:

$$W = \frac{pa}{70}$$

where

W = Weight in pounds per second;
p = Absolute pressure in pounds per square inch;
a = Area of orifice in square inches.

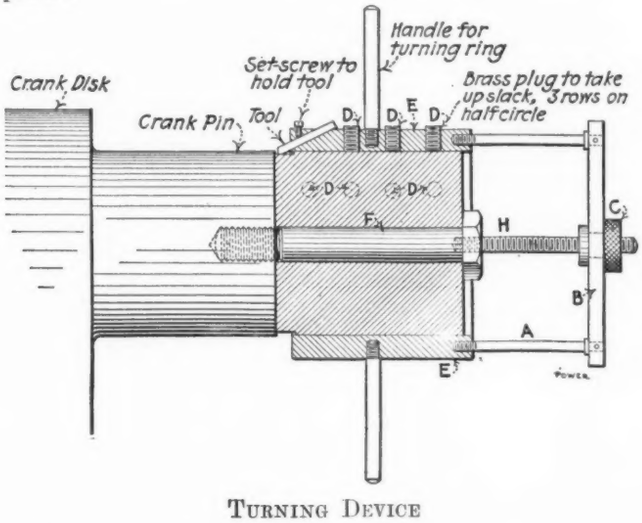
To my mind, a fan would require only about one-half the amount of steam and at the same time give the fireman much better control over his fire.

E. R. PEARCE.

Rochdale, England.

Truing Crankpins

The sketch shows a device which I made to true up some 6-in. pins. The following describes its makeup: The guide or supporting pin is secured to the crankpin by a bolt which fits the hole in the end of the crankpin; the feed screw is tapped into the head of the bolt. The crossbar B is secured to studs A by pins. The knurled hand feed C is made in two parts in order to assemble in crossbar B. Brass take-up plugs D, tapped a snug fit, are to hold the turning ring E steady. These plugs should be arranged four in a row on the half circle. When the first plug has passed over the end of the crankpin it should be brought to bear lightly, and when the cut is finished two should be still resting on the supporting pin F.



TURNING DEVICE

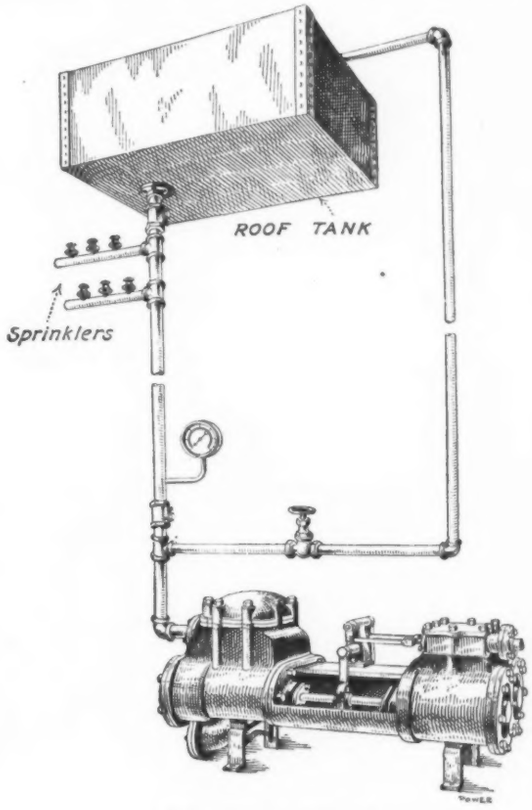
Four or six handles can be arranged on the circumference, depending on the size of the pin. The tool will have to be ground after the job is set up, on account of the peculiar angle, clearance, etc. The screw H for the feed should be a fine thread, not less than 20; 28 would be all right for a 6-in. pin, as then the hand-feed wheel C could be locked to crossbar B for the roughing cut.

N. E. WOOLMAN.

Kittanning, Penn.

Static Pressure?

The following installation shows a condition which puzzled us for some time. Water is pumped from supply mains in the basement of a large office building to a sprinkler tank on the roof. One feed line runs from the pump to the top of the tank to fill it. The other runs



SPRINKLER PIPING

from the pump to the sprinklers and to the bottom of the tank. This second line contains a check at the pump and another at the tank. The pump check was installed to prevent wasting the water in case the pump valves should not be tight. The check at the tank makes it possible to pump into the sprinklers without delivering water to the tank.

There is a gage in the sprinkler line which normally shows 105 lb., the pressure on the line. Imagine our surprise to see this gage pressure increase to 180 lb., with the pump standing idle, all apparently due to static pressure. We decided that the gage was at fault, and replaced it with another which showed 175 lb. Then we opened the pet-cock for drainage and the pressure returned to 105 lb., but it increased again the next day.

Knowing the height of the building had not changed, we set out to find the cause of the increased pressure. It seems that one of the steam lines ran parallel with the sprinkler riser; the water when heated by the steam ex-

panded, and not being able to escape on account of the check valves, it boosted the pressure.

We drilled a small hole through the upper check-valve disk to relieve the pressure and still not interfere with its function. Since then we have had no trouble.

H. C. WIGHT.

Philadelphia, Penn.

Emergency Repair to Ash-Hoist Engine

Some years ago I was assistant engineer on a steamship plying between New York and Tampico. On our arrival at Tampico on one trip it was found that the ash-hoist engine would not work on account of broken piston rings. As getting the ashes up by "Armstrong's" method (manual labor, in other words), was a tedious job, we removed the cylinder head and piston along with the broken rings. There being no spare rings on the ship, I used a piece of hemp rope as a substitute, after soaking it in cylinder oil and graphite.

The piston after some difficulty was finally entered in the cylinder and the engine put together. It was used in this way for one and one-half trips before new rings were put in.

A. ENGLAND.

New York City.

Putting in a New Crankpin

Truing out the eye and pressing in a new 11-in. crankpin on a 32¼x48-in. rolling-mill engine was done in the following way:

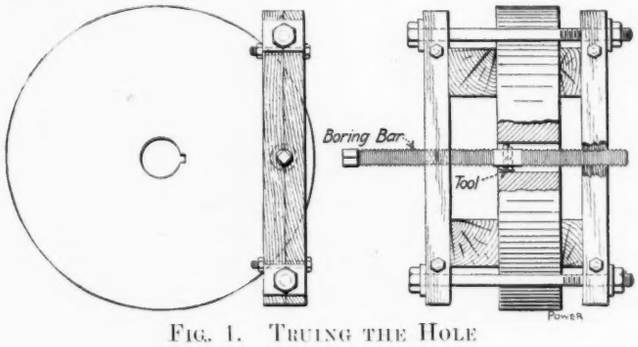


FIG. 1. TRUING THE HOLE

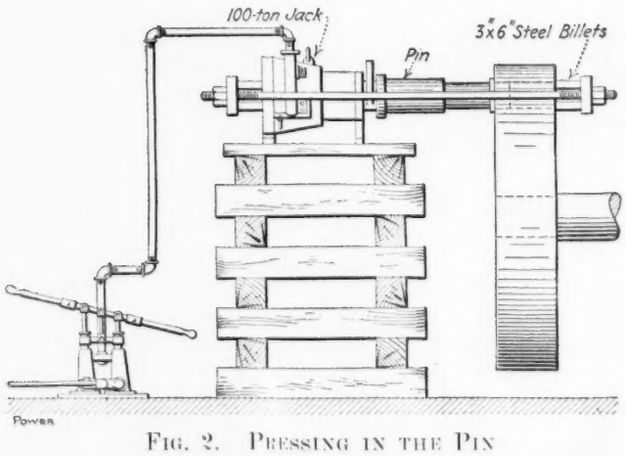


FIG. 2. PRESSING IN THE PIN

A boring bar was made from a piece of shafting with the cutting tools fastened in a slot about midway. A fine thread (No. 16), cut nearly its entire length, acted as a feed for the tool. The bar was clamped between two 4x4-in. hardwood timbers which were in turn clamped securely to the crank disk with distance blocks between (Fig. 1). The boring bar was carefully centered in the eye and squared with the disk. Turning the bar by means of a crank operated the cutters and the feed at the same time. Several light cuts were required to true the hole.

Pressing in the pin was done with a 100-ton jack, which was supported, as shown, and clamped to the crank disk by heavy rods with two 3x6-in. steel billets set edgewise for crosstrees (Fig. 2). When about the power limit of the jack was reached a blow with a sledge on the reverse side of the disk drove the pin home.

J. C. HAWKINS.

Hyattsville, Md.

Care of Manhole Gaskets

It is not uncommon to see manhole gaskets deluged with a preparation of graphite and cylinder oil before being put in place. A surplus of "dope" is the cause of many leaky manholes which sometimes means cooling the boiler to replace the gasket.

A small amount of graphite should be spread upon the side of the gasket which is to go next to the head; this is more to insure against trouble in removing the plate than for making a good joint. Flooding the side of the gasket which goes next the plate with an oily mixture is a mistake.

In such cases the gasket tends to slip off the rim. Unless the gasket is especially rigid, all added pressure from tightening will cause it to slip from the joint. Many gaskets on the market are provided with all the lubricant necessary for use. Experience has taught that a joint which will hold cold water will usually hold when hot water and steam are to be resisted. It is not advisable to pull up too tightly on the joint while it is cold. The joint should be watched while the pressure is being raised: a little drawing up may be needed when the parts become hot.

EDWARD T. BINNS.

Philadelphia, Penn.

Surging in Discharge Pipes

In operating centrifugal pumps with jet condensers, there is at times more or less "surging." Particularly is this so if the discharge pipes are long, as in cooling towers, and they have a number of turns. As such installations generally have the end of the pipe submerged, the surging is aggravated by the pulsating water in the hotwell. It starts when the pumps are underloaded, but when once started it will continue regardless of the load.

At times not only the pipe but the pump casing springs with each pulsation.

Bracing the pipe and strengthening the pump obviates to some extent the danger, but it does not remove the cause. I have found that one way to overcome the trouble to a great extent is to have a gage on the condenser and to operate the pump only fast enough to take care of the water; in other words, regulate by the throttle according to the gage reading.

JOHN F. HURST.

Louisville, Ky.

Inquiries of General Interest

Material for Producer-Gas Scrubber—What kind of filtering material should be used in a scrubber tank of a gas producer using anthracite coal?

E. C. A.

Use coke in the wet scrubber and excelsior in the dry scrubber.

Effect of Animal or Vegetable Oils in Feed Water—What effect on a boiler has the presence of animal or vegetable oil in the feed water?

R. B.

Such oils contain fatty acids and upon decomposing will cause pitting, especially in places where sludgy deposits are formed in the boiler.

Longer Cutoff, Less Load—On a compound engine if the low-pressure cylinder is doing more than its share of the work, how can part of the load be shifted to the high-pressure cylinder?

D. P.

By lengthening the cutoff of the low-pressure cylinder more of the work will be done in the high-pressure cylinder. For explanation of this paradox see the article "Shorter Cutoff Greater Load," by F. R. Low, page 180, Aug. 6, 1912, issue of "Power."

Efficiency of Boiler Joint—If the strength per unit of length of a butt and double-strap joint, double riveted, is 82,500 lb., and the strength of the solid plate for the same unit of length is 100,547 lb., what would be the efficiency of the joint?

C F.

The efficiency is the ratio of the strength of the joint to the strength of the solid plate for the same unit of length, i.e.,

$$\frac{100{,}547}{82{,}500}, \text{ or } 82 \text{ per cent.}$$

Static Electricity—What is static electricity and what would be the cause of it in a direct-current generator?

R. A.

Static (called also frictional electricity) is the electricity of stationary charges produced by rubbing together unlike bodies, such as glass and silk, in which case equal and opposite charges are always produced. In a belt-driven generator, static electricity would be caused by slippage of the belt on the pulley. The presence of static electricity is revealed by a spark or other manifestation of sudden discharge taking place when the static charge is grounded.

Coefficient of Friction—What is meant by coefficient of friction and how does the friction of solids vary?

C. R.

The coefficient of friction is the ratio of the force necessary to slide one body along another to the pressure between the bodies and varies with the character of the surfaces rubbed together. With most solids, friction, within the limit of abrasion, varies with the pressure and is independent of the extent of the surface, the time of contact or of the velocity, and when the surfaces are lubricated the friction is determined by the nature of the lubricant rather than the nature of the bodies which are rubbed together.

Methods of Superheating Steam—How is superheating of steam usually accomplished for power purposes?

C. R.

Steam is superheated by heating saturated steam, away from water to a higher temperature than its boiling point without changing the pressure, and for power purposes the saturated steam is usually heated in its passage through pipe coils (1) placed in the breeching between the boiler and chimney, or (2) placed in the boiler setting to obtain heat from the furnace gases before they leave the boiler, and sometimes before they strike the boiler, or (3) placed in an independent setting and separately fired.

Continued Running of Gasoline Engine—Why does a gasoline engine continue to run after the battery is disconnected?

J. M. D.

Continued running is usually due to expenditure of energy stored up in the flywheel. Continuance of explosions favorable to forward motion of the engine might result from ignition induced by particles of carbon or projecting parts having become heated from regular running of the engine and which had reached a temperature favorable to ignition at the time the battery was disconnected, but the combination of conditions would rarely be favorable to continue this running any length of time, preignition being likely to result.

Evaporation and Cooling—What occurs when evaporation from a surface makes it feel cooler, and why should air put in motion by a fan evaporate moisture any faster at higher velocities than at lower velocities?

J. W. D.

Up to its point of saturation, which varies with temperature and pressure, atmospheric air in contact with a liquid will absorb moisture, which is liberated from the liquid as vapor by the process of evaporation and heat, called the latent heat of evaporation, is always absorbed by a vapor in its passage from the liquid to the gaseous state. If the liquid does not receive heat as rapidly as it is absorbed in the process of evaporation, then the temperature falls and the cooling is greater as the evaporation is more rapid. Hence, with higher velocities of air set up by a fan, the cooling is greater as the increased rate at which the air is presented is accompanied by more rapid evaporation.

Noisy Exhaust Valves—How can a clattering noise of the exhaust valves of a Corliss engine be prevented?

C. G.

The noise is generally due to a valve being raised from its seat by pressure in the exhaust passages in excess of pressure in the cylinder, as when expansion in an underloaded noncondensing engine takes place below the pressure of the atmosphere. The remedy is to supply the engine with steam at lower initial pressure by reducing the boiler pressure or by throttling, so as to raise the terminal pressure. If it is impractical to reduce the initial pressure, the terminal pressure can be increased and the noise will usually be stopped by slightly opening the indicator cocks or by connecting together the indicator connections of opposite ends of the cylinder with a valve or cock between them nearly closed.

Pounding of Power Pump—What would cause pounding in a duplex power pump when used as a boiler feeder receiving water from an open heater, and how can it be remedied?

J. G. L.

Backlash or lost motion from wear of parts would cause hammering at each reversal of stroke, which could be remedied by taking up or refitting the crankshaft and connecting-rod bearings. Pounding of a piston or plunger occurs during the discharge stroke if the cylinder has not been completely filled with water during the suction stroke due to insufficiency of the suction head and sizes of suction passages for the given rate of piston displacement. Piston pounding can generally be reduced with practically no change of pumping capacity by running the pump at a slower speed or may be reduced with an increase of pumpage by lowering the pump and by increasing the sizes of the suction passages.

Measuring Cylinder Clearance—What is the best method of determining cylinder clearance of a Corliss engine?

G. W. B.

Set the engine on the center with the piston in the cylinder end where the measurement is to be taken. Remove the steam valve and fill the clearance space with water poured into the open port, drawing the water from a receptacle containing a quantity of water previously weighed or measured. When the whole space, including the port, is completely filled, the quantity remaining in the receptacle is to be weighed or measured to ascertain, by difference, the amount which has been poured into the port. Any water lost by leakage of the exhaust ports or piston, if small, may be accounted for by observing the rate of flow required to keep the port filled. At ordinary temperatures the weight of water may be taken as 0.03609 lb. per cu.in. (the weight at 62 deg. F.) The number of cubic inches of water required to fill the clearance space multiplied by 100 and divided by the piston displacement in cubic inches will be the per cent. clearance of the end of the cylinder measured.

Engineers' Study Course

Elementary Mechanics--XVI

Last Lesson's Answers

66. The force of friction will be the greatest when the normal pressure between the crosshead and the guide is a maximum. This will occur when the crank makes an angle of 90 deg. with the horizontal, as shown in Fig. 10, Lesson III, where the normal pressure is given by the line *ON*, assuming cutoff not before half-stroke.

67. (a) The motion of the crosshead is variable, as it moves first in one direction, then stops for an instant, and immediately moves in the opposite direction. Its motion might also be called *reciprocating*, since the direction of the motion changes with every stroke.

(b) The crankpin has uniform, rotary motion.

(c) A point on the rim of the flywheel has uniform, rotary motion. It might further be classified as *continuous* motion.

68. In one revolution of the engine the piston makes two strokes or moves through a distance of

$$2 \times 18 = 36 \text{ in., or } 3 \text{ ft.}$$

If the engine makes 250 r.p.m., the piston speed will equal $250 \times 3 = 750$ *ft. per min.*

69. The velocity of the crosshead is variable, since it changes from zero, when the engine is on dead center, to a maximum, when the crank and connecting-rod are nearly at right angles, and then back to zero when the engine reaches the other dead center. The velocity of the crankpin should be uniform, especially in engines directly connected to generators, where uniform rotation is essential to constant voltage.

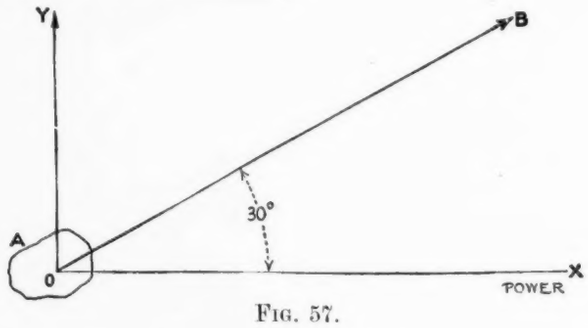


Fig. 57.

70. Four miles per hour is equivalent to

$$4 \times 5280 = 21{,}120 \text{ ft. per hr.}$$

which reduced to feet per minute is $\frac{21{,}120}{60} = 352$.

Therefore, since the fireman can walk at the rate of 352 ft. per min., it will take him $\frac{250}{352} =$ *about* $\frac{5}{7}$ *of a min.* to cross the boiler room.

Composition and Resolution of Velocities

A velocity, like a force, may be represented graphically in magnitude and direction by a straight line, drawn to a given scale, and having an arrow-head placed at the end of the line to indicate the direction of the velocity. Thus if the line *OB* (Fig. 57) is 2 in. long, and 1 in. represents 20 ft. per sec., the body *A* will have a velocity of 40 ft. per sec. in a direction of 30 deg. to the horizontal reference line *OX*.

Again, as for a force, a velocity may be resolved into any number of components. For convenience in dealing with problems, velocities will be resolved into their horizontal and vertical components. Velocities acting to the right or upward will be considered as positive, and those acting to the left or downward as negative. *The component of a velocity is the rate at which the given body is traveling in the direction of the component.* As an example, assume a train traveling due northeast at the rate of 40 miles per hour. Let this velocity be represented by the line *OB* (Fig. 58), making an angle of 45 deg. with the horizontal reference line *OX*. From the point *B* drop the perpendicular *BM*, forming the intercept *OM* on the line *OX*. In like manner find the intercept *ON*. Then the

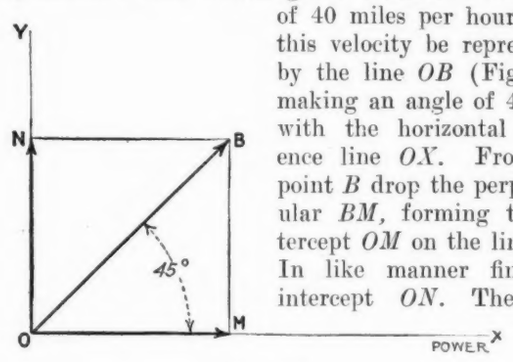


Fig. 58.

line *OM* will represent the rate at which the train is traveling east, and the line *ON* will give the rate at which the train is traveling north. But

$$OM = OB \times \cos 45 \text{ deg.} = 40 \times 0.707 = 28 \text{ miles per hour}$$

Likewise $ON = OB \times \sin 45 \text{ deg.} = 40 \times 0.707 = 28$ *miles per hour*

which means that at the end of one hour the train will be 28 miles east of its original position and 28 miles north. During the hour it has gone 40 miles in the direction indicated by the line *OB*.

Formulas (1) and (2) given under Lesson I may be used for finding the horizontal and vertical components of a velocity.

Resultant Velocity

The resultant of two or more velocities is a single velocity that will produce the same motion of a body as the combined action of the other velocities. If the velocities are parallel and in the same direction the resultant velocity will equal the sum of the two velocities. Thus suppose the conductor of a train walks toward the forward end of the car at four miles per hour, and at the same time the train is moving at 36 miles per hour. When the conductor stands still the train carries him 36 miles per hour, but when, in addition, he walks four miles per hour, he has a velocity of $36 + 4 = 40$ miles per hour relative to the earth. If the conductor walks toward the rear of the train he will have a velocity of $36 - 4 = 32$ miles per hour relative to the ground.

To illustrate the method of finding the resultant of two velocities, take an overhead traveling crane in the turbine or engine room of any large power plant. Let the line OX (Fig. 59) represent the center line of the crane, and the line OY the direction the crane moves in passing down the room. Assume the crane as stationary, and sup-

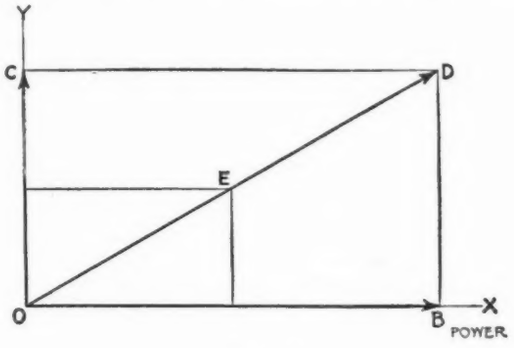


FIG. 59

pose a workman crosses the girder of the crane at V_2 ft. per sec., or at the end of a certain number of seconds (say, T) he arrives at the point B. Again, suppose the workman stands at the point O on the crane which is now moving down the room with a velocity of V_1 ft. per sec., and at the end of T sec. arrives at the point C. Now let the workman start at the point O and walk along the girder with a velocity of V_2 ft. per sec., and at the same time let the crane move down the room with a velocity of V_1 ft. per sec. At the end of T sec. the man arrives at B on the crane, but this point, due to the velocity of the crane has been moved to D. Therefore, the man, due to the combined action of his own velocity and that of the crane, has arrived at D. If both man and crane had moved for $T/2$ sec., at the end of this time the man would be at E. It must be evident that the points D and E lie on the same straight line OD which is the diagonal of the parallelogram $OCDBO$. If another man started at the same time as the crane and walked in a direction OD with a velocity of OD ft. per sec., he would be directly under the man walking on the crane girder, overhead.

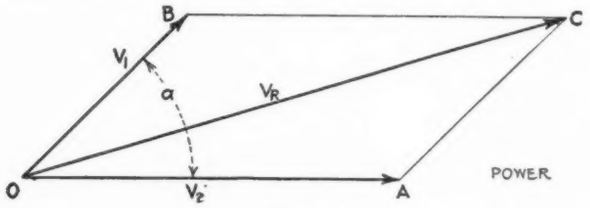


FIG. 60.

In other words, the diagonal OD represents the resultant velocity of the combined velocities V_2 and V_1. This statement could be proved equally well if the angle COB was either acute or obtuse.

From the foregoing discussion the following law known as the parallelogram of velocities may be stated. *If two velocities acting on a body at the same time can be represented in magnitude and direction by the sides of a parallelogram, the resultant velocity will be represented in magnitude and direction by the diagonal of the parallelogram drawn through the point of intersection of the two sides representing the given velocities.* Thus in Fig. 60, let the line OA represent a velocity of V_2 ft. per sec. and the line OB making an angle of a deg. with the first velocity represent a second velocity of V_1 ft. per sec. The resultant velocity will be given by the equation,

$$V_R = \sqrt{V_1^2 + V_2^2 + 2 \times V_1 \times V_2 \times \cos a} \quad (28)$$

The proof for this equation is similar to the proof of equation (5) given in Lesson II.

A body may have several simultaneous velocities not necessarily in the same plane. For example, take a body being raised by a traveling crane. At the same time the body is moving upward with a given velocity, it may also have a velocity due to the motion of the crane across the shop, and another velocity due to the motion of the trolley across the girder of the crane. The velocity of the body relative to the floor of the shop is then the resultant of three velocities.

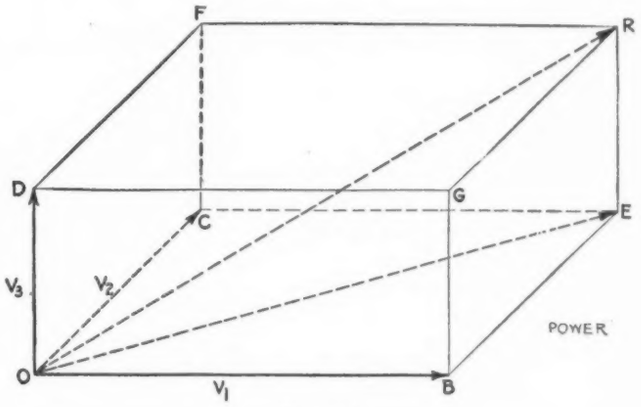


FIG. 61.

In Fig. 61 let the line OB equal the velocity V_1 with which the crane is traveling, the line OC equal the velocity V_2 with which the trolley is moving, and the line OD represent the velocity V_3 with which the body is being lifted. The diagonal OE is the resultant of the two velocities V_1 and V_2. This resultant combined with the velocity V_3 gives the final resultant velocity OR, whose value is found as follows:

$$OE^2 = OB^2 + BE^2 \text{ (since angle } COB \text{ is 90 deg.)}$$
$$= OB^2 + OC^2 \text{ (since } BE = OC)$$
$$\text{also } OR^2 = OE^2 + ER^2 \text{ (since angle } OER \text{ is 90 deg.)}$$
$$= OE^2 + OD^2 \text{ (since } ER = OD)$$
$$\text{hence } OR^2 = OB^2 + OC^2 + OD^2 = V_1^2 + V_2^2 + V_3^2$$
$$\text{and } OR = \sqrt{V_1^2 + V_2^2 + V_3^2} \quad (29)$$

STUDY QUESTIONS

71. The stroke of an engine is 12 in. If the engine makes 300 r.p.m., find the velocity of the crosshead when the crank makes an angle of 45 deg. with the horizontal. The length of the connecting-rod is 30 in.

72. A man rows a boat with a velocity of six miles per hour. The stream flows at two miles per hour. At what angle must the man point his boat so as to land at a point directly opposite his starting place?

73. With what velocity will he cross the stream?

74. If the stream is 1000 ft. wide, how long will it take him to row across?

75. A load is being hoisted at 200 ft. per min., by a crane which is traveling at 50 ft. per min. At the same time the trolley is crossing the crane at 75 ft. per min. Find the velocity of the load relative to the ground.

Measuring High and Low Temperatures*

By HERMANN HENRY ALBERS

It has been well said that "the history of modern industrial progress is the history of increased efficiency in production." In large technical enterprises, the highest efficiency is attained only by judicious management, coöperation, and the prudent selection of those mechanical devices designed to reduce manual labor and to obviate the human factor. Efficiency, probably more than anything else, has supplied the incentive for modern refinement in the manufacture of thermometric instruments and devices, and today there are instruments on the market which will not only measure but also record, with a high degree of accuracy, any temperature encountered in the industrial arts.

The measurement of temperature is of the utmost importance in the industries. On the one hand, certain processes and reactions occur only within a definite range of temperature, while, on the other hand, a deviation from a certain temperature may represent a loss. Progressive manufacturers and engineers in every field of production realize that temperature-controlling devices are conducive to a more uniform and better product, and are promotive of economies.

The name "thermometer," from its Greek derivatives "thermos" (heat) and "metron" (measure), suggests its use as a measure of temperature. As yet, no satisfactory definition of temperature has been given. It might be defined as a measure of the tendency for one body to transmit heat to another.

The unit of temperature measurement generally used by American engineers is the Fahrenheit degree, which may for the present be defined (in terms of the secondary standard) as equal to $^1/_{180}$ part of the apparent expansion of mercury between the point of fusion of ice and that of the ebullition of pure water under normal pressure (29.921" Hg). The Centigrade system, fast coming into general use, divides the dilatation of a column of mercury between the above mentioned points into 100 parts instead of 180, while the Réaumur scale (extensively used in the fermentation industries) employs 80 subdivisions. The Fahrenheit scale assumes the melting point of ice as 32 degrees, whereas the others take this point as 0 degrees. The following formulas may be used in transferring from one scale to another:

$$F = {}^9/_4\ R + 32 = {}^9/_5\ C + 32.$$

$$C = {}^5/_9\ (F - 32) = {}^5/_4\ R.$$

$$R = {}^4/_9\ (F - 32).$$

In order to measure temperatures, those properties of matter are utilized which are functions of the intensity of the heat to which they are subjected. Thus, lineal expansion, cubical dilatation, the thermo-electric force at the junction of two unlike metals, the electrical resistance of a conductor, the fusion points of different materials, the variable emissive power of bodies at high temperatures—all these and many other properties are employed in the design of modern thermometric instruments.

The various devices employed for measuring temperatures may thus be briefly classified according to the basic principles upon which they operate:

(1) Gas thermometers, which utilize the elastic property of the "fixed" gases.

(2) Liquid expansion thermometers, such as the ordinary mercurial instrument.

(3) Liquid pressure pyrometers, which measure the pressure exerted by confined liquids.

(4) Expansion pyrometers, which employ the unequal ratio of expansion of two different metals.

(5) Calorimetric methods, in which use is made of the known specific heats of various substances.

(6) Fusion methods, employing the melting points of different materials.

(7) Electrical pyrometers, in which either the varying resistance of a metal or the e.m.f. of a thermo-couple is measured.

(8) Thalpotasimeters, instruments utilizing the increase in vapor tension of a liquid.

(9) Optical and radiation methods, in which either the intensity of light emitted by a hot body is measured photometrically, or the total radiation (i.e., long waves which do not affect the eyes as well as the short light waves) is determined.

While the means for measuring temperatures are quite numerous, it has been found that for a specific case usually only one, or perhaps two, of the above classes serves the purpose best. Thus, the industrial engineer, employing thermometric instruments, should not only have a knowledge of the various instruments on the market, but he should also know the advantages inherent in the use of a particular apparatus. Further, many of the advantages claimed for the instruments as listed in the catalogs and expounded by salesmen, who only too often are actuated solely by a mercenary motive, are wholly illusory, and it requires the technical training and all the special knowledge an engineer may have on this subject, to discriminate between the real and these imaginary advantages. It is with this idea in mind that the writer has given a description of the various instruments, adding only enough theory to make the principle of operation more intelligible.

STANDARD THERMOMETRIC SCALE

The temperature scale has already been defined in terms of the mercury thermometer. On account of the variable coefficients of expansion of different qualities of glass, the definition of a standard thermometric scale in this manner is extremely difficult, if not impossible.

Theoretically, the thermodynamic scale devised by Lord Kelvin is ideal. Based on the principle of Carnot's cycle, temperatures measured on this scale are independent of the nature of the substance used. Thus

$$\frac{T_2}{T_1} = \frac{Q_2}{Q_1}$$

That is, the ratio of the heat absorbed to the heat rejected by an ideal heat engine is equal to the ratio of the respective absolute temperatures. This reduces the definition of temperature to the fundamental units of length, mass, and time, since Q_2 and Q_1 can be measured in terms of heat energy, which, by the laws of thermodynamics, is proportional to work. This scale, however, is unpractical and recourse must be had to some other method.

The elastic properties of gases were early recognized as a possible means of temperature measurement. The laws of Boyle and Charles, expressed mathematically in equation (1), show the relation between the volume, pressure, and temperature of a definite mass of an ideal gas. Thus

$$p\ v = m\ R\ T \qquad (1)$$

in which m equals the mass of the gas, and R the gas constant, the value of $\frac{(p\ v)}{T}$ for unit mass under the temperature of melting ice.

If p_0, v_0, T_0 represent the state of m lb. of a gas at the fusion point of ice, and p, v, T any other state, then we have

$$p\ v = m\ R\ T \qquad (2)$$

$$p_0\ v_0 = m\ R\ T_0 \qquad (3)$$

and

$$\frac{p\ v}{p_0\ v_0} = \frac{T}{T_0} \qquad (4)$$

If the volume remains constant, then

$$\frac{p}{p_0} = \frac{T}{T_0} \qquad (5)$$

and, likewise, the pressure remaining constant

$$\frac{v}{v_0} = \frac{T}{T_0} \qquad (6)$$

If the degree Centigrade is taken as the unit of measurement, the value of T_0 as determined by accurate experiments will be close to 273. In other words, the absolute zero of temperature is 273 degrees below the melting point of ice measured on the Centigrade scale.

Gas thermometers working upon the principles expressed by equations (5) and (6) are known, respectively as constant-volume and constant-pressure thermometers. Providing the same fixed reference points are used, the gas scale and the thermo-dynamic scale are identical.

HYDROGEN THERMOMETER THE STANDARD

Theoretically, any permanent gas may be utilized. Regnault, however, in his classic experiments on gases, found that

*Abstract of a paper entitled "Devices and Methods for Measuring High and Low Temperatures, with Special Reference to Engineering Problems," for which the author was awarded the Stillman Prize in Applied Technology, open to competition by members of the class of 1914, Stevens Institute of Technology.

Boyle's law was not rigorously exact, and that it was, therefore, impossible to select a gas "irrespective of nature, pressure, or mode of dilatation employed." The same experimenter also determined the pressure and volume coefficients of the different gases and discovered that the pressure coefficients for H_2 N_2, and CO at constant volume were practically identical, and also that the variation of this coefficient for H at constant volume was inappreciable. For this reason the hydrogen gas thermometer was accepted as the standard and defined Oct. 15, 1887, by the International Committee on Weights and Measures as follows:

The International Committee on Weights and Measures adopts as the standard thermometric scale for the international service of weights and measures the Centigrade scale of the hydrogen thermometer, having as fixed points the temperature of melting ice (0 deg.) and of the vapor of distilled water boiling (100 deg.) at standard atmospheric pressure, the hydrogen being taken at an initial manometric pressure of one meter of mercury—that is to say, 1000 ÷ 760 = 1.3158 times the standard atmospheric pressure.

This definition of the temperature scale is today universally accepted as the standard of reference between the interval of 0 and 100 deg. C.

[The author gives very creditable descriptions and illustrations of the principal types of thermometric instruments, which are manufactured for engineering purposes, concluding his thesis as follows:—Editor.]

SUMMARY

What is the best thermometric method? A single answer to this question, so frequently asked, is obviously impossible since the availability and choice of thermometric methods depend upon the conditions involved in particular problems. The following, however, may be taken in a general way as a criterion relative to the behavior of the more important instruments just described in respect to range, calibration and precision.

For temperatures within the interval of —30 to 400 deg. F., the mercury thermometer is recommended where conditions permit; it is cheap, accurate and simple. Where temperatures are to be controlled from some central point, or are to be recorded, the resistance thermometer presents considerable advantages. It can be used with great precision, will rapidly indicate small variations in temperature and can be employed from absolute zero to 1300 deg. F. For temperatures up to 3000 deg. F., the platinum thermocouple is quite generally accepted. The base metal couple, on account of its low initial cost, gives an instrument suitable for many thermal operations between 500 and 1300 deg. F. Where the temperature is higher than 3000 deg., or where the object operated upon is inaccessible, it being in motion, the radiation and optical pyrometers are without substitutes. The latter may be obtained in slightly more portable form and can usually be focused quicker upon the body under consideration than the radiation pyrometer, but its readings are dependent to a certain extent upon the personal factor of the observer. The radiation type is purely mechanical in operation but is generally more expensive.

In conclusion, it may be stated that there is no universal thermometer or pyrometer which can be used for all purposes. To give satisfactory results each case should be considered by itself, and the instrument employed should be adapted for the special purpose.

Pulverized Coal for Steam Making*

By F. R. Low†

SYNOPSIS—Many attempts have been made to use pulverized coal as a fuel under boilers, but few have persisted, and a small proportion of the coal used for steam making is burned in this way. The article mentions some of the earlier attempts and describes some of the systems upon which present effort is being expended. The proportionately large surface exposed by the finely comminuted fuel for oxidation makes perfect smokeless combustion with a minimum air supply possible. Combustion under such conditions results in an unsupportable furnace temperature. If this is reduced by increasing the excess air, efficiency is sacrificed; if by reducing the amount of fuel fed, capacity is limited. The overall advantage of this over the less expensive stoking methods in common use is yet to be proved.

Numerous attempts have been made in the past quarter century to use pulverized coal as a boiler fuel. The published accounts of the various trials are full of promise and apparent accomplishment, but few of the processes have persisted, and only a small proportion of the coal used in steam making is fired in this way.

There have been three broad types of apparatus produced; that of which the Pinther (Fig. 1) is typical, where the prepared coal is emptied into a hopper above a feed-controlling mechanism and carried into the furnace by the natural draft; that having a mechanical feed, as the revolving brush of the Schwartzkopff apparatus (Fig. 2); and that in which the coal is blown into the furnace, as in the Day or Ideal apparatus (Fig. 3).

With the first type, efficiencies of from 75 to 80 per cent. were obtained, but the capacity was limited. When sufficient draft was applied to introduce a considerable amount of fuel, the velocity was such as to carry unconsumed particles of coal into the back connection and tubes. When fuel is introduced into a powdered fuel furnace at a rate which will give the full rated capacity of the boiler, a

*From a paper before the American Society of Mechanical Engineers at Minneapolis, Minn., June 1914.

†Editor of "Power."

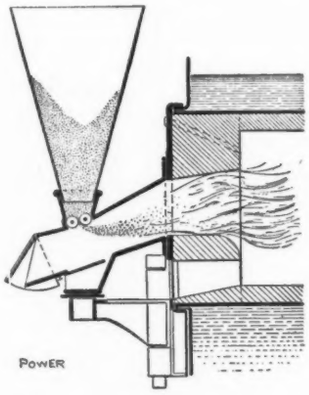


Fig. 1. Pinther Type of Apparatus

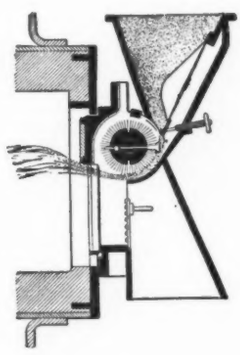


Fig. 2. Schwartzkopf Apparatus

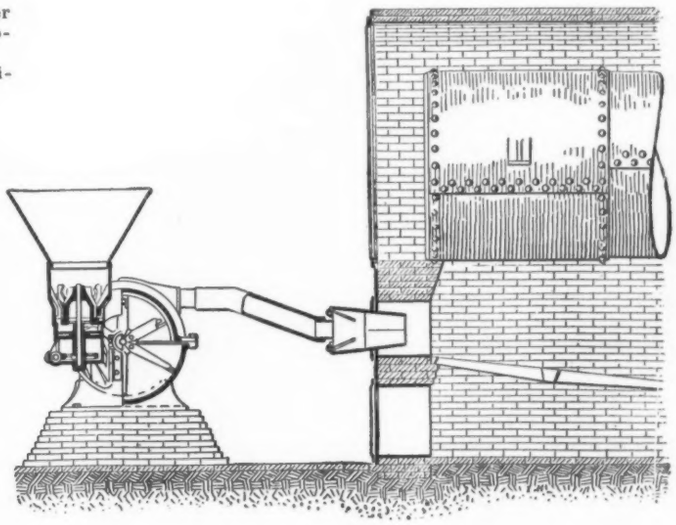


Fig. 3. Day or Ideal Apparatus

particle will remain less than half a second in the combustion zone of an ordinary furnace.

The first installation that I ever saw for burning pulverized coal under a boiler was of the rotary brush type and was in the late nineties. The apparatus was applied to a horizontal return tubular boiler at Quincy, Mass., set in the usual way. The brush injector was placed at the furnace door and upon the grate was a thin fire composed of coal the size of hickory nuts. There was no way of feeding coal to this fire and none was necessary. Enough of the coal failed to be consumed in suspension, and fell and agglomerated itself upon the fuel bed to keep it supplied. The powdered coal in bags was dumped into the hopper above the brush. The chimney was smokeless, the fire box cloudy, but the combustion chamber full of clean white flame. The apparatus never reached the publication stage.

When it is suggested that an air blast be used to introduce the fuel, the apprehension of an excess of air is felt. The relative volumes of equal weights of coal and air are about 1:990. It would hardly be expected to use less than 15 lb. of air per pound of coal, so that the relative volumes of coal and air introduced would be

$$1 : (990 \times 15) = 1 : 14{,}850$$

The diameter of the globe of air which would accompany each tiny particle of fuel into the furnace would be $\sqrt[3]{14{,}850}$ or over twenty-four times the diameter of the particle of coal, so it will be seen that plenty of air may be used for fuel injection purposes without exceeding the supply required for complete combustion. In all of the systems at present in use, the fuel is introduced in this way, the blower usually being so combined with the pulverizer that the pulverized coal is blown into the furnace as fast as it reaches the necessary degree of fineness.

That the subject has not been neglected by inventors is evidenced by the fact that during the past 20 years there have been 23 United States patents issued for pulverized coal apparatus.

The earlier attempts to utilize pulverized coal were in connection with metallurgical processes. J. S. Dawes used it in England, in 1831, in blast furnaces, injecting it with the air through the tuyeres. It was proposed or tried in iron works by Desboissierres, in 1846, by Mouchel, in 1854, and by Mushet, in 1856. Somewhat later, Crampton tried it in locomotive and other boilers.

In 1876, Chief Engineer B. F. Isherwood, U. S. N., described* a test made by naval engineers under his direction in 1867 and 1868 at South Boston, upon an apparatus devised by James D. Whelpley and his partner, Storer, for firing a boiler in part with pulverized fuel. The boiler was of the horizontal two-flue type having only 299 sq.ft. of heating surface and 13½ sq.ft. of grate. A coal fire was maintained upon the grate and the pulverized fuel fed in above it, a fire arch being used to maintain the furnace temperature when the powdered fuel was used, but not with the grate alone.

Tests were made both with anthracite and semi-bituminous coal. The highest rates of combustion attained were 13.8 lb. per sq.ft. of grate per hour for the anthracite, and 14.9 for the bituminous, referring all the coal burned, pulverized as well as solid, to the grate area. Mr. Isherwood's conclusions were that, including the cost of pulverizing, the anthracite did a good deal better and the semi-bituminous a little better, when burned upon the grate in the ordinary way than when burned in part in the pulverized condition.

In the late nineties, D. Wegener brought out in Europe and tried in this country a natural-draft system. Tests showed boiler efficiencies of from 75 to 80 per cent. In 1910, J. E. Blake installed under a 300-hp. water-tube boiler at the Henry Phipps power plant in Pittsburgh, the arrangement shown in Fig. 4. The pulverizer served as its own blower, sending the pulverized fuel mixed with air to the furnace, where, in this installation, it was introduced by a series of nozzles extending across the width of the furnace. A little less than the rated horsepower of the boiler was obtained with an efficiency of about 79 per cent.

A later form of the Blake apparatus was installed last winter at the Peter Doelger Brewery, in New York City. The powdered coal was delivered into the top of an extension furnace or dutch oven, as shown in Fig. 5. Smokeless combustion and high efficiency were obtained, the principal trouble being from slag, which accumulated on the roof and sides of the furnace, and piled in such masses upon the floor that frequent shutdowns were required for its removal. As much water was evaporated with 1000 lb. of the pulverized as with 1400 lb. of the natural coal, but the cost of furnace maintenance, the frequent laying off of the boiler for the removal of slag and the cost of pulverizing counteracted, in the opinion of the operators, these advantages and the system was abandoned after a trial of about eight weeks.

In 1905, John B. Culliney, superintendent of the American Iron & Steel Mfg. Co., patented the controlling device shown in Fig. 6. The powdered fuel is deposited in the hopper A, filling the chamber B, when it is carried forward by the horizontal screw conveyor and dropped in a continuous stream through the chamber C. Radial rods upon the conveyor shaft agitate the mass, and push any foreign or uncomminuted material which may have been introduced with the fuel out to the sides, where swinging cover plates DD are provided for its removal. Connected to each side of the chamber C is a blast pipe E, the opening for which is shown in the longitudinal section at F. A current of air flowing through the pipe and across the falling stream of pulverized coal picks up a portion of it and carries it to the larger pipe G, where it is taken up by another air current and carried into the furnace. About one-seventh of the total air is supplied at the smaller pipe under a pressure of about 6 oz., the remainder of that necessary to complete combustion being supplied by the larger pipe under a pressure of 1½ oz. or less. The part of the coal which is not taken up by the blast is returned to the upper chamber by the inclined screw of coarser pitch, and carried forward again through the same process. Regulation of the speed of the conveying screws, and of both air supplies, gives the operator complete control of the rate of feeding and character of the flame. This system has found a wide application, not only for large metallurgical work, but for many furnaces where oil and producer gas were formerly used.

This system has been for some time in successful use for shop processes at the Schenectady works of the American Locomotive Co., and has recently been installed for steam-making purposes under a 300-hp. Franklin boiler. The arrangement is shown in Fig. 7. The results, up to this writing, have been complete smokeless combustion, no slag, several furnace linings melted down, but inability to get full boiler capacity. This is laid to limited controller capacity, and larger controllers are being installed.

Claude Bettington, of Johannesburg, South Africa, where the price of coal is high, attacked the problem by designing a boiler especially for use with pulverized fuel. He took out his first patent in the United States, but his boiler was first commercially exploited in England. In his boiler the feed is upward, as shown in Fig. 8, through a water-jacketed nozzle in the center of a vertical furnace. The pulverizer acts as a blower, and the air supply is preheated. From the pulverizer the coal passes to a separator, where the larger particles settle out and return to be again treated, the finer passing on to the burner. The blast, about 2 in., opposing gravity, tends to keep the coal in suspension, and as a particle would have to pass twice the length of the furnace (upward and downward) to escape, there is no difficulty in obtaining complete combustion.

The flame does not lift more than 10 per cent. under the highest rate of feed which it is practicable to employ, the temperature of the furnace and of the enveloping gases being increased enough to offset the greater velocity of ingress. The tubes of the inner row of the circular furnace are covered with a special refractory covering to within a short distance of the bottom header, making a brick-lined combustion chamber. The special bricks are placed loosely around the tubes, but soon become coated with molten ash and slag, which welds them into a solid wall, and closes the crevices between the lining and the top header. The ash which is not so slagged to the furnace surfaces, or carried out by the draft, drips into the ashpit below the lower header. The destructive effect of the impinging flame upon the brickwork is avoided by taking it upon the lower head of the central drum, or upon the accumulation of gas in the upper end of the chamber, the region of greatest heat intensity being in the core, while the tubes and shell are subjected to the lesser temperature of the somewhat cooled gases, which have not yet got away. The radiant heat is, however, effective upon them and the metal surfaces must be kept clean, and particular care taken to maintain a safe water level. One of these boilers having 2606 sq.ft. of heating surface has been running for over four years at the works of the builders. It evaporates regularly 14,000, and has been worked up to 22,000 lb. of water per hour. These rates, however (5.4 and 8.4 lb. per sq.ft. of heating surface) are attained with stoker fired boilers.

A contributor to "Power" who has had two of these boilers in charge says* that the steel head of the upper drum

*Engineering and Mining Journal.

*"Power," May 12, 1914, page 678.

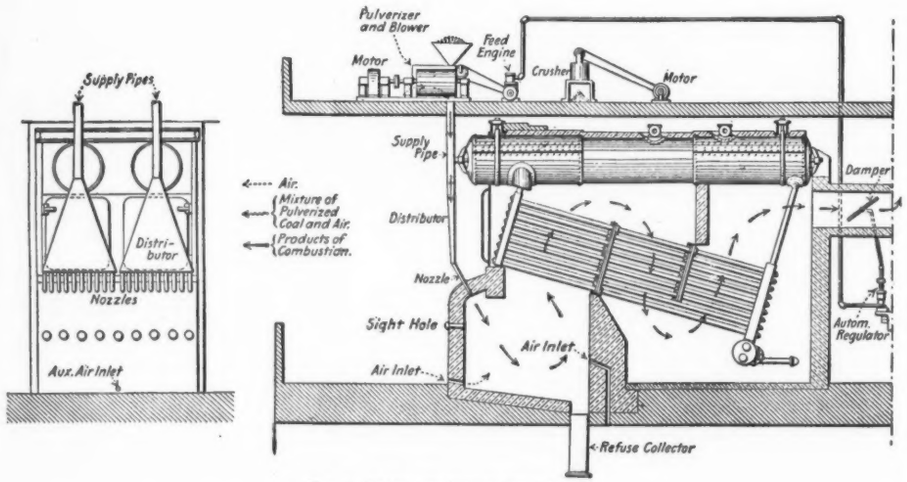


FIG. 4 BLAKE AND PHIPPS INSTALLATION

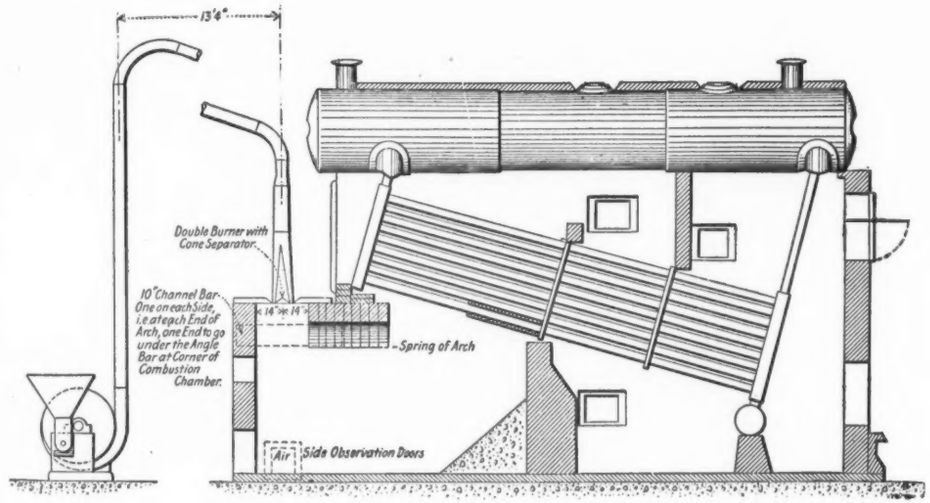
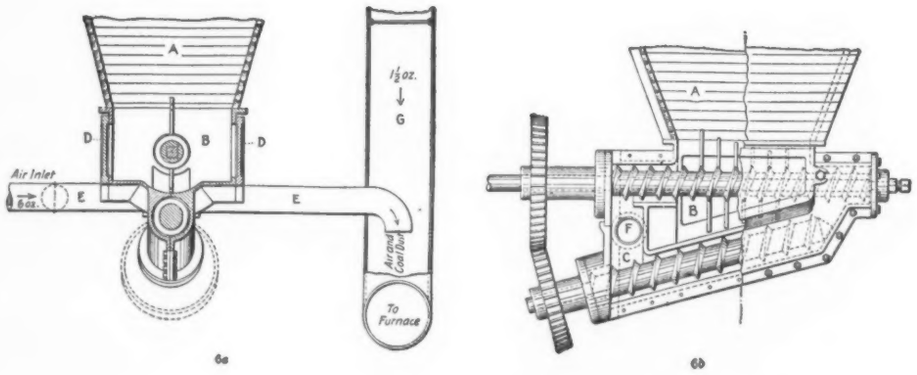

13'6"
Double Burner with Cone Separator.
10" Channel Bar. One on each Side, i.e. at each End of Arch, one End to go under the Angle Bar at Corner of Combustion Chamber.
14"
14"
Spring of Arch
Air
Side Observation Doors

FIG. 5 DOELGER INSTALLATION



FIGS. 6a AND 6b CULLINEY FEEDING

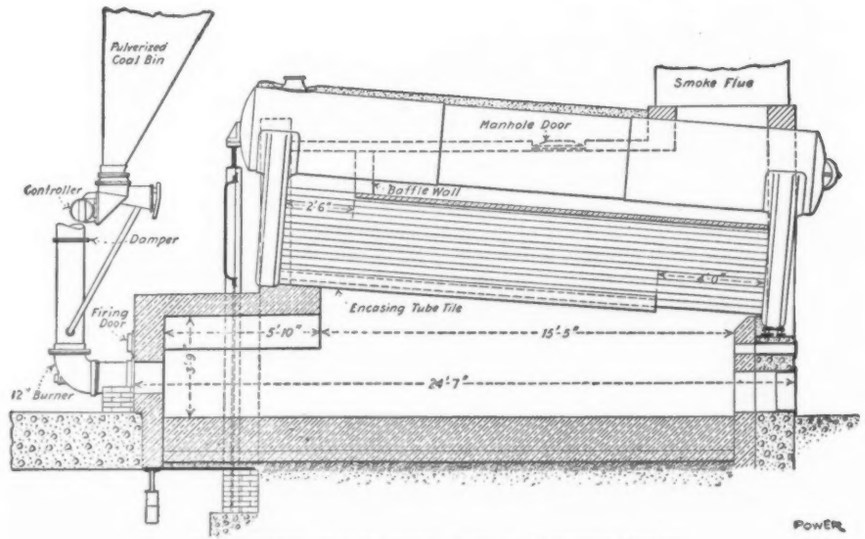


FIG. 7 300-H.P. FRANKLIN BOILER, AMERICAN LOCOMOTIVE COMPANY

burned through at one time, probably due to dirt collecting upon it; that in spite of the cooling effect of the tubes the special bricks forming the furnace quickly burn away. Care must be taken lest the lining burn through and the gasses be short-circuited. Although this boiler will burn low-grade fuel successfully, and while under steam is easily managed, one fireman being able to look after several boilers, these advantages are largely offset in his opinion by high maintenance charges.

The makers say their experience has been that a lining will last about two years, and that even large holes will automatically seal up. The parts which require most frequent renewal are the beaters and liners of the pulverizer. These are of manganese steel, and can be replaced in about two hours. The approximate life for the beaters is 1500, and for the liners, 2000 tons of coal handled. A user, after 10 months' experience, says that the blades run from 1000 to 1200 hours per set, and that the second set of liners was still in use. The use of heated air in the pulverizer allows coal having 15 per cent. or more of moisture to be handled successfully; a separate heater is recommended for large boilers. Two to 3 per cent. of the boiler capacity is allowed for pulverizing. There was some trouble from leaky water jackets putting the flame out, but this has been overcome by the use of welded jackets.

Tests of one of these boilers showed an efficiency of 82.6 per cent., the coal having 2.15 moisture, 22.8 volatile, 57.55 fixed carbon, 17.5 ash. The CO_2 is carried at 15 per cent. in regular practice.

With the ordinary method of burning coal, the grate with its bed of solid incandescent fuel more or less encumbered with ash and clinker, offers a considerable, a varying, and an uneven resistance to the passage of air, rejects the incombustible residuum with some difficulty and allows some of the unburned fuel to sift to the ashpit or to be fused with the clinker. If the fuel can be burned in suspension, many of these difficulties disappear and the draft-producing apparatus is reduced to that which will remove the products of combustion and allow enough air to enter to burn the required amount of fuel. There still remains, however, the difficulty of getting rid of the incombustible. With 10 per cent. ash there will be 200 lb. of refuse to be got rid of with each ton of coal burned. If this is kept in a pulverized form it is carried into the back connection, the tubes and stack, and scattered about the neighborhood. If it is fused it attaches itself to the surfaces of the furnace and welds itself into masses, occasioning damage to the brickwork in its removal and comparatively frequent layoffs for cleaning. In one instance, the molten slag formed in sheets and ridges upon the sides and in stalactites upon the roof of the furnace, while the floor was covered with a plastic mass, which cooled when the door was opened for its removal, and could hardly be got out without material damage to the furnace.

The possibility of getting an adequate supply of oxygen to the finely comminuted carbon allows perfect and smokeless combustion with a minimum air supply, but with rates of combustion demanded in present practice, the result is a high temperature with erosive and reducing characteristics which, however good they may be for metallurgical processes, are not favorable to the longevity of a boiler furnace. If this temperature is kept down by feeding less fuel, the capacity is limited, while if kept down by using an excess of air the economic advantage is sacrificed.

There have been several disastrous explosions of the prepared fuel outside of the furnace, but these can be easily guarded against. Coal, however finely comminuted, does not contain the elements necessary for its own combustion, and if ignited will burn slowly if kept in a compact mass. It is only when it is diffused in a cloud that the oxygen of the atmosphere can get to it quickly enough to make the rate of combustion dangerous. The pulverized fuel can be safely conveyed en masse in suitable holders, in screw conveyors, or in cars and barrows if care is taken that it shall not be blown or sifted about in a finely disseminated state. In those systems where the pipe back of the blower is filled with an explosive mixture of coal and air, the rate of flow must exceed that of the propagation of flame in such a mixture, and in shutting down, the coal supply should be shut off first. The pulverized mass will run like water, so that the pitch of chutes, conveyors, etc., must be so set as to provide against the flowing of their contents.

While anthracite dust can be used it burns more slowly than coal higher in volatiles, and must be very finely pulverized. For most systems practically all of the coal should go through a screen having 100 meshes to the inch, and for coals having a small percentage of volatile or where very rapid combustion is imperative, the coal is ground to a fineness which will permit the greater part of it to pass through a 200-to-the-inch sieve. Low-grade coals and coals having a large percentage of ash can be burned in this way, but there is a limit to the proportion of slate and bone that one can afford to grind, and an increasing proportion of ash means increased trouble from dust and slag.

The earlier practice of taking up the impingement of the flame on a checkerwork or a heap of brickbats is out of favor. It simplifies the process of keeping the burner lighted, but burns too much firebrick and makes a locus for the building of a slag heap. With an ordinary firebrick furnace well heated up there is no trouble in maintaining the flame steady, and it will reignite after having been turned out for several minutes.

The cost of pulverizing and the large initial cost of the

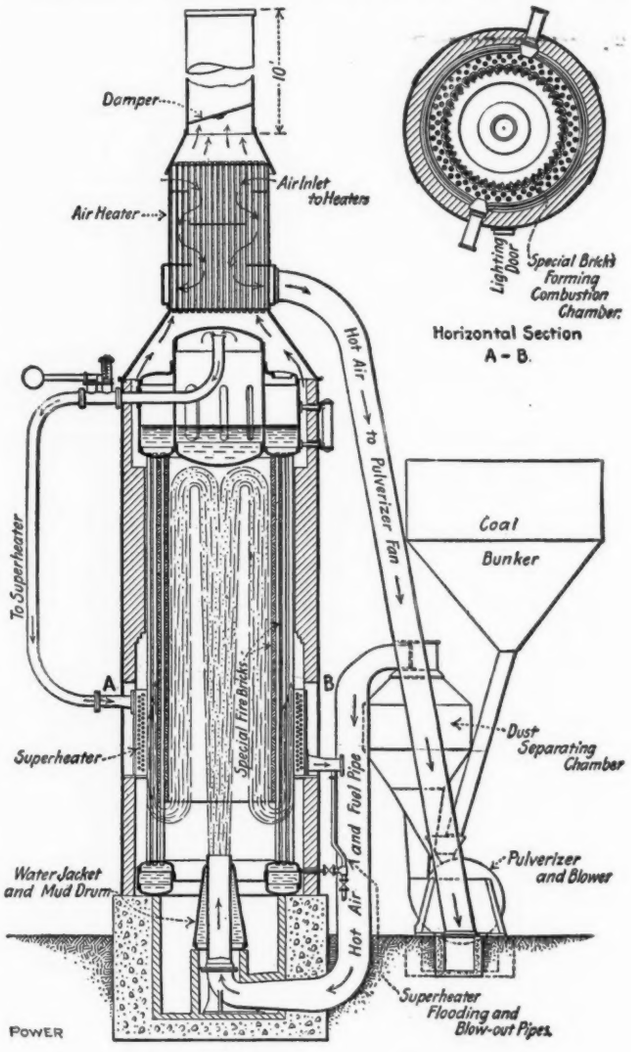


FIG. 8. BETTINGTON BOILER

drying, pulverizing, conveying and feeding apparatus, together with the fact that coal of practically all grades can be burned with a tolerable degree of smokelessness in the cheaper apparatus in common use with a degree of efficiency which leaves little margin to cover the increased expenditure, have combined to restrict the use of pulverized coal for boiler purposes.

Brotherhood of Boilermakers' Convention—One hundred and twenty-five delegates from various parts of the country attended the eleventh biennial convention of the International Brotherhood of Boilermakers, Iron Ship Builders and Helpers, which began at San Francisco on June 9.

Westinghouse Elects Directors—On June 10 the Westinghouse Electric & Manufacturing Co. elected the following directors at the East Pittsburgh plant: A. G. Becker, Wm. McConway, John R. McCune, George M. Verity, Paul M. Warburg, H. H. Westinghouse, P. D. Cravath and J. N. Wallace.

Temperatures in Electrical Apparatus*

Electrical apparatus is unfortunate in the use, as an important material of construction, of cotton, paper and similar fibrous materials having a weak mechanical structure and subject to deterioration at relatively low temperatures. The general use of these materials in electrical apparatus has justly placed on it the handicap of low operating temperatures and has emphasized the important relation between operating temperature and safe capacity and length of life.

The temperature conditions existing in a large alternator armature core and winding are illustrated in Figs. 1 to 3, the first representing a cross-section of a coil in the end windings surrounded by air on the four sides. The curve shows the temperatures existing along the line. The temperature of the copper, a — c, is shown to be 70 degrees C., with a slight drop toward the surface. A drop of about 30 degrees is shown through the coil insulation and there is a further drop of 20 degrees from the surface of the insulation to the surrounding air.

It is difficult to measure the surface temperature by a mercury thermometer without changing the heat resistanc of the circuit and thus changing the temperature being measured. As surface temperatures are ordinarily measured, a mercury thermometer is placed in contact with the surface and the thermometer is covered by an insulating pad; the effect of this pad is shown in Fig. 2. The copper temperature may be increased, more heat flows through the insulation on the uncovered side of the coil (resulting in the larger drop shown) and a still greater part of the heat flows through the paths of less resistance adjacent to the covered part of the coil. Very little heat flows through the path,

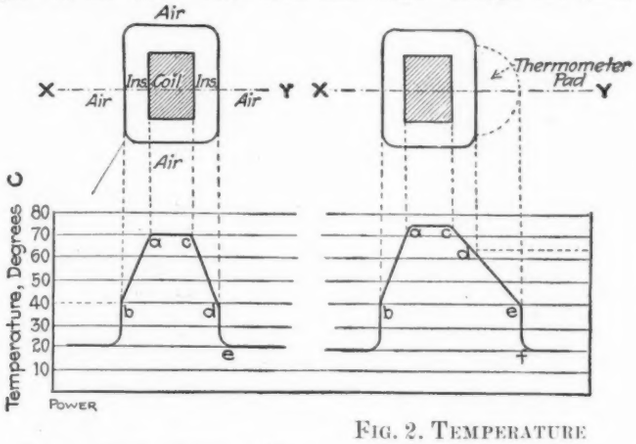


FIG. 1. TEMPERATURE DIAGRAM OF ARMATURE COIL IN AIR

FIG. 2. TEMPERATURE DIAGRAM OF ARMATURE COIL IN AIR WITH THERMOMETER PAD

including the thermometer pad, with the result that the temperature drop through the insulation is greatly reduced and the thermometer indicates a temperature nearer the true copper temperature than the true surface temperatures.

Fig. 3 illustrates the temperature drops and direction of heat flow within the core through the center of the slot along the line YY. It has been assumed that the load and design are such that the copper temperature is higher than that of the core, so that the heat flows from the copper to the core. The highest temperature is shown in the center of the coil nearest the air gap. The loss in this coil is often greater than in the coil beneath it, due to the penetration of the air-gap flux within the top of the slot. On the other hand, the heat flow from the top coil is sometimes greater, due to the greater conductivity of the path passing through the wedge to the air.

But little heat flows through the insulation between the coils, since they are at nearly the same temperature. There is a very large flow of heat from the slot and tooth belt through the core to the outer core surface which produces the large temperature drop shown, in spite of the relatively low heat resistance of the sheet steel.

In Fig. 4 is shown the temperature drop along the longitudinal path from the part of the coil in the center of the core, along the copper, and through the end insulation to the air.

*Abstract from a paper by F. D. Newbury before the National Electric Light Association.

LIMITING TEMPERATURES OF INSULATING MATERIALS

Insulating materials in common use for coils may be conveniently grouped in two classes from the standpoint of temperature:

1. Cotton, silk, paper and other fibrous materials.
2. Mica, asbestos and similar heat-resisting materials.

Obviously, the fibrous materials have a much lower limiting temperature than those in the second class. However,

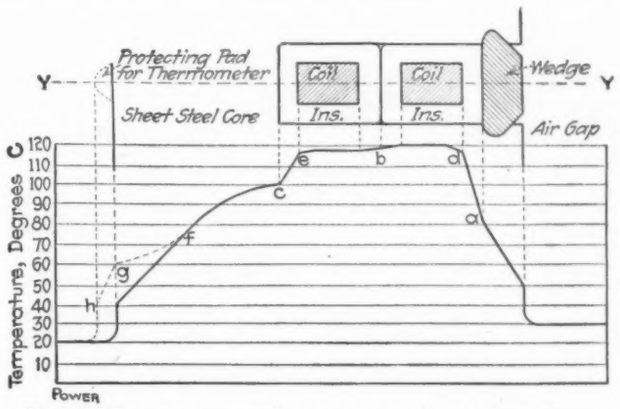


FIG. 3. TEMPERATURE DIAGRAM OF ARMATURE COILS AND CORE (IN DIRECTION OF LAMINATIONS)

the materials in that class are usually used for armature coil insulation, with those of the first-class serving as a means of mechanical support for the main insulation. In this connection it may be mentioned that machine-wrapped mica insulation will operate satisfactorily at higher temperatures than hand-wrapped.

The temperature limit of pure mica or asbestos is so high that when either is used alone, as is often the case in turbo-field insulation, and sometimes in armature-coil insulation, the temperature limit is imposed by other parts of the apparatus than the insulation.

While experience with mica and paper (combined) insulation has shown that it can safely withstand such temperatures as 200 or 300 degrees, these high temperatures are not advocated for generators of normal design. The following gives a conservative limit for the different insulating materials:

Kind of Insulation	Temperature Limit	Remarks
(1) Treated cotton, paper, silk and similar fibrous materials.	105 deg.	This limit is well established and probably will not be increased by future experience except under conditions of low voltage and rigid support.
(2) Mica, asbestos and similar refractory materials, used without lower temperature materials, as in some turbo-generator field windings.	No limit	The temperature limit is so high that meterials or conditions other than insulation impose the limit.
(3) Combinations of (1) and (2) in which both classes of materials are necessary for insulation strength.	105 to 125 deg.	The limit in a particular case depends on the relative proportions of the two classes of materials and on the application.
(4) Combinations of (1) and (2) in which materials of the first class are used for structural purposes only and are not depended on for insulation strength.	150 deg.	Experience has defined this limit less rigidly than in the other classes. Future experience will undoubtedly justify raising this figure.

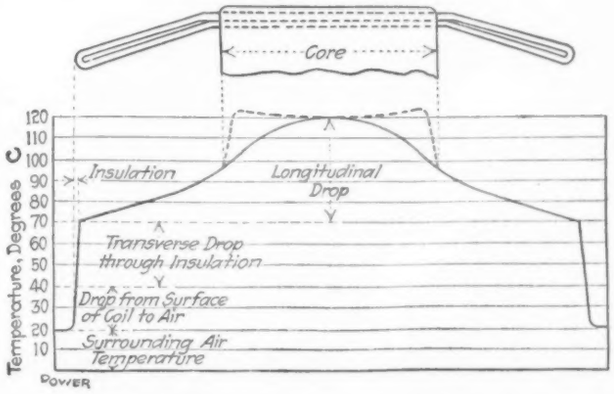


FIG. 4. LONGITUDINAL TEMPERATURE DIAGRAM OF ARMATURE COIL

TEMPERATURE MEASUREMENTS

Measurements by means of mercury thermometers show the surface temperatures, which are less than the nearest heat source, by a drop which is partly determined by the covering applied outside the thermometer.

Temperature measurements by increase in the resistance of the winding itself give average temperatures which are higher than those at the surface unless the drop through the insulation is negligible or the hottest part of the heat source is accessible to the mercury thermometers.

Much higher results than either of the foregoing are obtained by means of thermo-couples which record approximately the hottest temperature of the heat source.

Boilermakers National Convention—The International Brotherhood of Boiler Makers, Iron Shipbuilders and Helpers of America, in 11th biennial convention, elected the following officers at San Francisco, Calif., on June 20: International president, J. A. Franklin, Kansas City, Kan.; first vice-president, A. Hinzman, Kansas City; second vice-president, Thomas Nolan, Portsmouth, Va.; third vice-president, J. P. Marrigan, Montreal, Canada; fourth vice-president, Louis Weyand, Cleveland, Ohio; fifth vice-president, John P. Down, New York; sixth vice-president, William Atkinson, Los Angeles; seventh vice-president, M. A. Maher, Portsmouth, Va.; eighth vice-president, Joseph P. Ryan, Chicago; ninth vice-president, John F. Schmitt, Columbus, Ohio; secretary-treasurer, Frank R. Einemeyer, Chicago; editor of "Journal," James B. Casey, Kansas City.

Careless Firemen—A careless or ignorant fireman will often throw into a furnace twice as much coal as is needed, usually piling it near the front of the grate while the sides and edges are relatively thin. By leaving holes in the fire bed or allowing the firing doors to remain open unnecessarily, he admits excess air into the furnace which reduces the temperature of the flue gases.

"The Engineering Manual," published by the American Electric Railway Engineering Association is now being distributed. This publication is a compilation of the standards and recommendations adopted by this association and covers practically the entire field of electric railway engineering. The book is in loose-leaf form, and has 82 sections, fully illustrated with diagrams and working drawings. The loose-leaf form was adopted so that the standards and recommendations may keep pace with such additions and alterations as are made at the yearly conventions of the associations. Separate sections may be obtained. The price to nonmembers of the association is $3, and binders $1 extra. Members will receive the manual (without binder) free.

Pennsylvania State Convention

Probably the largest and most successful convention of the Pennsylvania State Association of the N. A. S. E. was held in Philadelphia, on June 19 and 20. The Vendig Hotel was the headquarters. The attendance of delegates was exceptionally large.

The business sessions took place in the Parkway Building, next door to the headquarters hotel. The exhibition hall was also in the Parkway, and provided plenty of light, with ample space for the exhibits.

On Friday morning at ten o'clock Peter O. Johnson, chairman of the convention committee, opened the convention for the preliminary exercises. After a few words of welcome to the city officials who were present, Mr. Johnson introduced the Hon. George D. Porter, director of public safety, who spoke warmly of Philadelphia and its environments, and extended to the delegates and guests a hearty welcome.

Samuel B. Forse, national treasurer of the N. A. S. E., responded in suitable terms for the engineers.

National President James R. Coe, whose name was not on the program, and appeared as a pleasant surprise, was then introduced, and spoke interestingly of the progress of the N. A. S. E.

AT THE PENNSYLVANIA STATE CONVENTION, N. A. S. E., PHILADELPHIA, JUNE 19-20, 1914

The convention then went into executive session, and after the various committees were appointed the meeting adjourned until 2 p.m.

The entertainment program included an afternoon automobile trip for the ladies about the city and suburbs, paying a visit to College Inn, where a sumptuous chicken dinner was served, the company returning to the hotel at seven o'clock.

Promptly at 8:30, in the large auditorium of the Parkway Building, the entertainment given by the supplymen took place. A most enjoyable evening was furnished by the following: Hart and Neal, Monroe Silver, Pauline Lorraine, Brendel and Morgan, Pauline Newman, and the Musical Ogdens, of the supplymen, and Herbert Self, Peerless Rubber Manufacturing Co.; Joseph Hickey, Keystone Lubricating Co.; Andrew McHugh and Joe McKenna, Jenkins Bros., and Jack Armour, of "Power"; Bob Nolan was at the piano.

The entertainment features wound up with a smoker on Friday night.

At the final meeting of the delegates the following state officers for the ensuing year were elected:

President, James D. Rostron, Chester; vice-president, Peter O. Johnson, Philadelphia; secretary, R. B. Ambrose, Pittsburgh; treasurer, D. E. Seeley, Du Bois; conductor, C. W. Leitenberger, Johnstown; doorkeeper, Earnest Uff, Chester.

THE EXHIBITION

The following firms had representatives in attendance:

Albany Lubricating Co.
American Bitumastic Enamels Co.
Magarvey & Griffith
Morris Metallic Packing Co.
McArdle & Cooney

Ames Iron Works
Anchor Packing Co.
Barnett Manufacturing Co.
Bell Coal Co.
Bird-Archer Co.
Bond Co., Charles
Borgner Co., Cyrus
Budd Grate & Foundry Co.
Dearborn Chemical Co.
Dixon Crucible Co., Jos.
Durabla Manufacturing Co.
Fairbanks Co.
Ford & Kendig Co.
Frick Grate Bar Co.
Garlock Packing Co.
Goodall Rubber Co.
Greene, Tweed & Co.
Griscom-Russell Co.
McClave-Brooks Co.
National Ammonia Co. of Pennsylvania
National Flue Cleaner Co.
National Supply & Equipment Co.
Newton Coal Co., George B.
Nazel Engine & Machine Works
Parkesburg Iron Co.
Peerless Rubber Manufacturing Co.
Philadelphia Grease Manufacturing Co.
"Power"
Quaker City Rubber Co.
Robinson & Son Co., Wm. C.
Roebling's Sons Co., John A.
Harrison Safety Boiler Works
Home Rubber Co.
Homestead Valve Manufacturing Co.
Houghton & Co., E. F.
Jenkins Bros.
Johns-Manville Co., H. W.
Keystone Lubricating Co.
Kruger & Blind Co.
Lagonda Manufacturing Co.
Livezey, John R.
Lunkenheimer Co.
Rooksby & Co., E. J.
Strong, Carlisle & Hammond Co.
Underwood & Co., H. B.
United States Graphite Co.
Vacuum Oil Co.
Watson & McDaniel Co.
Walsh Packing Co.
Webster & Co., Warren
Westinghouse Electric & Manufacturing Co.
Williamson & Cassedy

We regret that we were unable to secure a photograph of the delegates and guests in time for publication.

The next meeting will be held at Pittsburgh, June 18 and 19.

Annual Meeting of American Institute of Electrical Engineers

The thirty-first annual convention of the American Institute of Electrical Engineers, at Detroit, on June 22 to 26, although not as large in attendance as some former meetings, ranked well in the character of its technical sessions and in its enjoyment of the opportunities offered by that city for entertainment and inspection trips.

With headquarters at the Hotel Ponchartrain, the convention began with a reception and dance on Monday evening.

PRESIDENT'S ADDRESS

On Tuesday morning President C. O. Mailloux opened the technical sessions with an address on "The Evolution of the Institute and Its Members." As one of its charter members, he reviewed the phenomenal growth of the Institute and pointed out that, although one of the youngest of the national engineering societies, it has now taken a place in the front rank. Much of this success had been due to the untiring work of the committees and the active members who have gratuitously rendered service, which money could not hope to buy.

Due to the ever-increasing scope of electrical engineering, new specialties have sprung up, some of which have assumed sufficient importance in the number of persons interested and the technical work done to warrant separate associations such as the Electro-Chemical and the Illuminating Engineering societies. While the formation of these two had been justified, in Mr. Mailloux's opinion, it was not wise to subdivide a large field into too many independent societies. He believed the whole field of electrical engineering could be served best by the parent society, comparing it to a central station with a high diversity factor.

Mr. Mailloux concluded his address with a plea that engineers as a class should take a greater interest in civic affairs. "Our neglect," said he, "to occupy the place that belongs to us is a serious handicap to the prestige and influence of our professional class, and places it in a condition of relative disparity before the world as compared with other professions such as law, medicine and fine arts. * * * Only in exceptional cases do we see engineers vested with the authority which gives the final decision; indeed, they are never in a majority in a deciding body."

D. B. Rushmore indorsed the president's remarks and added that in public-service commissions the engineers are often consulted on important matters, but occupying a subordinate position, have no voice in the final decisions. This condition he believed was partly because their training was along specialized lines and partly because the average engineer is not a highly trained executive.

ELECTRICITY IN MARINE WORK

The first paper of the morning was "Electric Heating as Applied to Marine Service," by C. S. McDowell and D. M. Mahood. Among the advantages pointed out were simplicity and low cost of installation, saving in weight, freedom from leaks, noises and disagreeable odors as compared to steam, and ease of regulation. Attention was called to its use for first and second cabins on some of the latest Atlantic liners.

"The Electrically Driven Gyroscope in Marine Work," by H. C. Ford, was the next paper. The gyro-compass, said the author, makes use of the earth's daily rotation and consequent changing direction of gravity to secure a directive force a hundredfold greater and more accurate than that of the magnetic compass. This type of compass as adopted by the United States Navy was described. While large gyroscopes are made capable of stabilizing any ship against rolling in the heaviest seas, one of its principal applications promises to be in aëroplane work.

INDUSTRIAL POWER

The industrial power session was held Tuesday evening and consisted of three papers: "Direct-Current Motors for Coal and Ore Bridges," by R. H. McLain; "Methods of Keeping Down Peaks on Power Purchased on a Peak Basis," by T. E. Tynes, and "Concatenated Induction Motors for Rolling Mill Drive," by William Oschmann.

Mr. McLain described the mechanical arrangement of a coal bridge, consisting essentially of a trolley car with hoisting mechanism for a self-filling bucket. A series motor was recommended for driving the trolley car and for a slow-speed hoist, whereas a shunt motor is best for a high-speed hoist. The relative merits of both types were discussed.

The method described by Mr. Tynes for keeping down peaks on the purchased power was as follows: Exhaust steam being available from pumps, air compressors, etc., a low-pressure turbine was installed to handle the peaks. This is kept running light on the line and by means of a special contact attached to the maximum-demand meter, relay circuits are closed and operated to short-circuit sections of resistance in the field rheostat of the turbo-generator. This raises its voltage and causes it to take the peak load. Conversely, when the demand goes off, the resistance is cut in on the rheostat and the voltage of the machine is lowered, thus reducing its load.

Mr. Oschmann's paper described a six-speed concatenated induction motor set for driving the finishing rolls of a 12-stand mill. It consisted of a double-wound main motor and single-wound secondary motor, both stators mounted on a common bedplate, and both rotors on a common shaft. The larger motor has both a 14- and a 16-pole stator winding and the secondary motor has its winding arranged for four- and eight-pole connections. The motor has six definite speeds and two additional resistance speeds, and the control is such that no regular attendant is required.

Following this paper, moving pictures were thrown on the screen showing the operations in the mills of the National Tube Co., from ore to finished pipe.

ELECTROPHYSICS

Wednesday morning was devoted to a session on electrophysics, three papers being presented: "The Sphere Gap as a Means of Measuring High Voltage," by F. W. Peek, Jr.; "The Electric Strength of Air," by J. B. Whitehead and W. S. Gorton, and "Sphere-Gap Discharge Voltage at High Frequencies," by J. C. Clark and H. J. Ryan.

ENGINEERING DATA

Two reports were rendered on Thursday morning by the committee on engineering data. The first, which was presented by Chairman Percy H. Thomas, represented the practice of twenty-five power companies operating at 25,000 volts or over. Full particulars on the transmission-line constructions, as well as operating features, were given. Owing to its importance an abstract of this report will appear in a subsequent issue.

The second report of the committee dealt with "Specifications for the Inspection and Tests of High-Tension Line insulators."

PRIME MOVERS

Thursday afternoon, H. G. Stott read the committee's report on prime movers in which reciprocating steam engines, steam turbines, gas engines, oil engines and hydraulic turbines were compared as to relative importance, capacity, efficiency, weight, cost and economy.

During the past five years the reciprocating steam engine, said Mr. Stott, has become practically obsolete for use in modern power stations. It is still used in isolated plants where exhaust steam is used for heating, and in this service has some advantage over the small turbine, although the margin is continually becoming smaller.

He quoted figures to show that the large steam turbine has now passed the gas engine in thermal efficiency, the only prime mover now surpassing it being the Diesel engine, which has a maximum operating efficiency of about 28 per cent. compared with 24 per cent. for the latest 20,000-kw. high-vacuum steam turbines. The data and curves from this report will appear in a later issue.

Following Mr. Stott's report was a paper on "Voltage Testing of Cables," by W. I. Middleton and C. L. Dawes.

Charles F. Brush, of arclight fame, was the recipient of the Edison Medal on Thursday evening, at which time the past-president's badges were also presented. President-elect Paul M. Lincoln was introduced and made a short address.

ELECTRO-CHEMICAL SESSION

Friday morning was devoted to three papers, "Sterilization of Water by Ultra Violet Rays," by M. von Recklinghausen; "Toll Telephone Traffic," by Frank F. Fowle, and "A High-Speed Printing Telegraph System," by Carl Kinsley.

This was followed by a conference of section delegates and officers.

ENTERTAINMENT

The entertainment features consisted of automobile trips about the city, a boat ride to Bois Blanc Island, inspection trips to the Ford plant and the stations of the Detroit Edison Co., a dance and cabaret on Thursday evening, a card party for the ladies, and tennis and golf tournaments for which handsome trophies were awarded.

The B. F. Goodrich Co. plant was next visited. Guides were provided and the visitors were divided into squads and conducted through a large part of the 75 acres of floor space. They were shown everything from the grinding and compounding of the rubber to the finished products, including auto tires, hose, belting, valves, boats, insulated wire and products of rubber in every shape and description.

The trip ended at the company's offices where refreshments were served and souvenirs were distributed, including small hot-water bottles for the ladies and watch fobs for the men.

The traction company then transported all the delegates to the Goodyear Tire & Rubber Co. Here again Akron hospitality was shown at its best. Guides were provided and a hurried trip was taken, beginning at the power plant, thence through the various rooms. The Goodyear Co. served supper to all in the company dining rooms. The way six people served the crowd with such efficiency was a marvel to the visitors.

The committee of arrangements deserves especial mention for the fine program of Wednesday evening—to say nothing of the concert conducted by "Prof." Raven, N. A. S. E., Thursday evening.

Dayton, Ohio, was chosen for the next meeting place.

EXHIBITORS

Akron Metallic Gasket Co.
H. W. Johns-Manville Co.
C. E. Squires Co.
Factory Oil Co.
Ohio Injector Oil Co.
Leavitt Machine Co.
Griscom-Russell Co.
Goodyear Tire & Rubber Co.
"National Engineer"
"Power"
William Powell Co.
Bowers Rubber Works
Trill Indicator
Peerless Rubber Manufacturing Co.
Dearborn Chemical Co.

A Group at the Ohio N. A. S. E. State

Burt Manufacturing Co.
B. F. Goodrich Co.
Lagonda Manufacturing Co.
Arrow Boiler Co.
Jenkins Bros.
Greene, Tweed & Co.
American Steam Gauge & Valve Manufacturing Co.
Cling-Surface Co.
Keystone Lubricating Co.
Howe Rubber Co.
V. D. Anderson Co.
White Star Refining Co.
Perolin Co. of America
Garlock Packing Co.
Hawk-Eye Compound Co.
H. Mueller Co.
Crandall Packing Co.
Hill, Hubbell & Co.

Ohio State N. A. S. E. Convention

The annual convention of the Ohio State N. A. S. E. took place at Akron on June 17 to 19, with an excellent attendance, the delegates convening at 9:30 Wednesday morning in East Market Street Rink.

After the opening ode "America" and the invocation by the Rev. L. N. D. Wells, Mayor F. W. Rockwell welcomed the delegates, W. E. Lewis, of Massillon, No. 14, responding.

President F. A. Seiberling, of the Goodyear Tire & Rubber Co., and a former president of the Akron Chamber of Commerce, delivered a most interesting address on "Akron—Its Manufactures." State President J. E. Radigan made an appropriate response. The morning session closed by singing the "Red, White and Blue" and with prayer by the Rev. Mr. Wells.

The afternoon session began at 1:30 o'clock.

In the evening, at eight o'clock, the exhibition was formally opened. A male chorus of 36 under the direction of Prof. Griffith, and vocal and instrumental solos furnished the music.

On Thursday morning, after a short business session the Northern Ohio Traction Co. provided special cars for all to visit the Gorge power house. The party was then taken on flat cars to the hydro-electric plant a mile down stream. All the delegates took part in strenuous reducing exercises and climbed the 175 steps back to the cars.

Indiana State N. A. S. E. Convention

On June 10 to 12, Indiana engineers held their tenth annual convention at the Hotel Severin, Indianapolis. Discussion on a state license law and the formation of chapters at Fort Wayne, and Hammond were the features of the business sessions.

On Wednesday evening there was a smoker in the exhibit hall, following a lecture by Mr. McMeans on "Practical Engineering."

On Friday afternoon the engineers visited the storage-battery plant of the Indianapolis Light & Heat Co., and in the evening attended a chicken supper at Broad Ripple Park.

Richmond was selected as the convention city for 1915. The following officers were elected: Louis Minke, Evansville, president; Albert Franke, Terre Haute, vice-president; Ignatz Baldus, Indianapolis, secretary; Albert T. Arens, South Bend, treasurer; W. E. Mutchnes, Richmond, conductor; Elza Scott, Kokomo, doorkeeper; E. G. Huger, Evansville, state deputy.

Following is a list of the exhibitors:

Greene, Tweed & Co.
"National Engineer."
"Power."
The Garlock Packing Co.
American Steam Gauge & Valve Mfg. Co.
Indianapolis Belting & Supply Co.
Dean Bros. Steam Pump Wks.
Crane Co.
Griscom-Russell Co.
Hide, Leather & Belting Co.

Hawk-Eye Compound Co.
The V. D. Anderson Co.
Dearborn Chemical Co
Home Rubber Co.
The Lunkenheimer Co.
White Star Refining Co.
H. Mueller Co.
Wm. Powell Co.
Jenkins Bros.
H. W. Johns-Manville Co.
The Perolin Co. of America
Crandall Packing Co.
Keystone Lubricating Co.
Henry Vogt Machine Co.
Central Supply Co.
Central Rubber & Supply Co.
Crescent Oil Co.
Indian Refining Co.
Quaker City Rubber Co.
Trill Indicator Co.
Open Coil Heater & Purifier Co.
Home Brewery
Standard Oil Co.
Vonnegut Machinery Co.
Chandler & Taylor Co.
Arrow Boiler Compound Co.
Hetherington & Berner.
Indianapolis Electric Supply Co.
Garrett-Callahan Co.

Connecticut N. A. S. E. Convention

The nineteenth annual convention of the Connecticut State Association of the N. A. S. E. was held at Bridgeport, Conn., on June 26 and 27, with headquarters at the Stratfield Hotel.

The preliminary ceremonies took place at Friday noon, Frank J. Quinlan, chairman of the local committee, presiding. After a short address Mr. Quinlan introduced the Hon. Clifford B. Wilson, mayor of Bridgeport, who spoke of the city's large large commercial interests and of its national attractiveness. He warmly welcomed the engineers and guests. James R. Coe, national president, replied for the engineers, and paid a tribute to the supplymen for the support they have always given to the engineers in their business and social dealings with the N. A. S. E. Bernard J. Reynolds, state president, then addressed the meeting. Mr. Quinlan formally opened the supplymen's exhibition, after which the delegates went into executive session.

The meetings of the delegates were held in a hall in the Eagles' Building, and in the large Auditorium adjoining the supplymen had their mechanical display.

On Friday evening a smoker was held at which a most enjoyable entertainment was given, and refreshments of all kinds were served. Auto trips through the city were enjoyed by the delegates and guests.

At the final meeting of the delegates the following state officers were elected: Charles Dowd, president; James J. McGee, vice-president; Elmer E. Thomas, secretary-treasurer; Oscar A. Thomas, conductor; Andrew A. Anderson, doorkeeper; Bernard J. Reynolds, trustee. The officers were installed by National President James R. Coe, who also presented a past-president's jewel to the retiring state president, Thomas J. Phillips.

At a meeting of the Connecticut State Supplymen's Association, held on Saturday morning, these officers for the ensuing year were elected: Edward J. Birge, president; John H. Foote, vice-president; Harry H. Glynne, secretary-treasurer; George H. Kendrick, chairman; N. S. Burnham, John F. Harrington, William Muller and Frank T. Bulkley, trustees.

THE EXHIBITORS

Bridgeport No. 4, N. A. S. E.
Garlock Packing Co.
McLeod & Henry Co.
Eagle Oil & Supply Co.
Dearborn Chemical Co.
American Steam Gauge & Manufacturing Co.
Greene, Tweed & Co.
Philadelphia Grease Manufacturing Co.
Peerless Rubber Manufacturing Co.
Durabla Manufacturing Co.
McClave-Brooks Co.
Pratt & Cady Co., Inc.
Mightingale & Childs Co.
Hartford Mill Supply Co.
The Lyon & Grumman Co.
The Hawley Hardware Co.
Kilpatrick Hotz Co.
J. H. Richardson
Robert A. Keasby Co.
Perfection Grate Co.
Pyrene Sales Co.
Jenkins Bros.
Otis Elevator Co.
Keystone Lubricating Co.
The Lunkenheimer Co.
Diamond Power Specialty Co.
The C. S. Merrick Co.
H. W. Johns-Manville Co.
"National Engineer"
"Power"
The Wellington Co., Inc.
Wm. L. McLellan
Home Rubber Co.
Crane Valve Co.
The Babcock & Wilcox Co.
Crandall Packing Co.
The Roto Co.
Mason Regulator Co.
Walter G. Ruggles Co.

The next convention will be held at Hartford in June, 1915.

Government Coal Analyses

Dealers and users are depending more and more on government analyses for comparison and for determining the best and cheapest fuel. Each summer the Geological Survey issues a small pamphlet giving analysis made by the Bureau of Mines of the coal samples that the Survey has collected during the year. These analyses are made for the purpose of obtaining data upon which to classify and value the public lands, and for general information regarding the various coal fields of the United States.

The latest pamphlet of this series (Bulletin 541-K) gives the analyses of 135 samples collected by uniform methods in Alabama, Colorado, Illinois, Kentucky, Montana, New Mexico, Oregon, Pennsylvania, Utah, Virginia, West Virginia and Wyoming. The heating value is given with almost all the analyses, so that it is easy to determine which of two coals is the better. The bulletin also gives a brief description of the samples, including a section of the coal at the point sampled, and an outline of the different classes of coals recognized by the Geological Survey.

A copy may be obtained on application to the Director of the United States Geological Survey, Washington, D. C.

CONVENTION AT AKRON, OHIO, JUNE 17 TO 19, 1914

Progress of Department of Machinery, Panama-Pacific Exposition

Since the return of Lieut. George W. Danforth, U. S. N. (retired), chief of the department of machinery of the Panama-Pacific International Exposition, from a tour of the Eastern States, the department has been engaged upon the allotment of space in the Palace of Machinery. As so many applicants asked for a large space, the 360,600 square feet were over-applied for and it became necessary to reconsider each application so that all allotments have been appreciably reduced.

The exhibits will comprise the finest collection of electrical and machinery exhibits ever assembled under one roof. The exhibitors are coöperating with the department in associating their exhibits with others which will permit of complete operation and demonstration.

On April 1, preliminary work was started on the installation of the first exhibit, a 500-hp marine Diesel engine, by the Busch-Sulzer Bros. Diesel Engine Co., St. Louis, and the first pile for the foundation was driven with appropriate ceremonies on May 27 by Captain Asher Carter Baker, director of the division of exhibits. The installation will cost $70,000.

The entrance to the Palace of Machinery will be handsomely decorated with palms and shrubs. To attract the

non-technical visitor there have been arranged many spectacular exhibits through the operation of pumps, etc., and beautiful and artistic effects, such as water-falls and illuminated fountains.

The most modern methods of illumination will be displayed in connection with the exhibits and will interest the layman as well as the student and those vitally interested in such affairs. One phase will be the isolated electric-house-lighting systems for farm use compared with the most complicated systems for city lighting. The testing of the high-potential insulators and transformers will be made possible by arrangement with the largest manufacturers of high-voltage testing apparatus.

A feature of the Palace of Machinery will be the methods employed for the convenience of the visitors. A number of plans are now being tested to insure engineers and students the opportunity to make a careful examination of each exhibit in privacy and comfort. Reception spaces will be provided in connection with each exhibit and equipped with suitable fixtures which will enable technical visitors to prepare notes on the various features.

All of the working exhibits will be equipped with the latest "safety-first" devices and these guards will form one of the most interesting exhibits to the engineer and manufacturer.

The Department of Machinery will soon take possession of the offices which have been built inside of the Palace and will remain there until the close of the exposition. The gates will open Feb. 20, and will close on Dec. 4, 1915. Nine of the eleven principal exhibit buildings are now complete and the others will be finished in less than thirty days.

BOOKS RECEIVED

OIL FUEL FOR STEAM BOILERS. By R. T. Strohm. McGraw-Hill Book Co., New York. Cloth; 145 pages, 4½x7 in.; 63 illustrations; tables. Price $1.

COX'S COMMERCIAL CALCULATOR. By Edward L. Cox. Funk & Wagnalls Co., New York. Cloth; 101 pages, 7x11 in.; 99 pages of tables. Price, $10.

NEW PUBLICATIONS

FUEL. By J. S. S. Brame. Published by Longmans, Green & Co., London, 1914. Size 9x6 in.; 372 pages; 52 tables, 72 illustrations. Price $3.50.

The author's object is to place in the hands of technical men, not fuel specialists, as full information on fuels of importance as is possible in a single volume. In the preface he makes a plea for government laboratories for investigating the fuel (presumably of the British Isles) as the subject is studied by the United States Bureau of Mines.

The book is divided into four parts, treating of solid fuels, liquid fuel, gaseous fuel and the analysis, purchase and utilization of fuels. The author has collected a wealth of information from sources generally recognized as the best; in fact, this is one of the most complete treatises on commercial fuels that we have had the pleasure of reviewing.

MARINE STEAM. Second edition, 1914. Published by the Babcock & Wilcox Co., New York and London. Size, 7x10 inches; 220 pages; illustrated.

The second edition of "Marine Steam," just issued by the Babcock & Wilcox Boiler Co., is to the marine trade what "Steam" (by the same company) is to the stationary. This book contains a fund of general information besides the illustrated history of the evolution and the development of the water-tube boiler from its earliest forms. The marine types of water-tube boilers are dealt with in detail, showing all forms of Babcock & Wilcox marine boilers.

It is of interest to know that water-tube boilers are now in use aboard every type of steam craft, and in all the navigable waters of the globe. Many complete test reports are given in detail which afford a basis of comparison with others, ashore or afloat. The typography and the illustrations are excellent, which, coupled with the accepted reliability of the data it contains, makes this a reference book worthy of a place in any engineering library.

McANDREW'S FLOATING SCHOOL. By Captain C. A. McAllister. Published by International Marine Engineering, New York, 1914. Size, 9x6 in.; 245 pages; cloth. Price, $2.

Composed of reprints from "International Marine Engineering," the book is in the nature of story lectures on marine engineering to firemen, oilers, and coal passers, although engineers will find the book of value. A good conception of its purpose and treatment is gained by the following, which is in substance a synopsis of the first chapter. Four ambitious firemen aboard a coasting steamer determine, on arriving at an East River pier, to request the chief engineer, a man who worked himself up from the coal bunkers, to instruct them while the ship is idle during the winter when new boilers are to be installed. The chief agrees and the floating school goes into session. Beginning with simple explanations of force, work and power, the chief takes his class on through heat and the generation of steam, engineering materials, boiler fittings, draft, engines, condensers, pumps and all that marine engineers have to care for and manage. As the purpose of the firemen in taking instructions is to pass examinations and obtain engineers' licenses, questions and answers are given in the back of the book. There are thirty-eight illustrations and several tables.

STEAM SUPERHEATERS. By the Babcock & Wilcox Co., New York City. Cloth; 80 pages, 7½x10¼ in.; illustrated.

The Babcock & Wilcox Co., among the first, if not the first, to recognize the advantage of real technical and engineering worth in its advertising literature, has just issued a volume upon superheated steam, uniform in size, style and binding with its well known "Steam." It contains 80 pages, including many illustrations, and, in addition to describing the superheater as made by the Babcock & Wilcox Co. has a most valuable compilation of information upon the general subject. It would be fairer to say that it contains the descriptive matter in addition to the compilation, for the latter is really the bulk of the book. After explaining the difference between superheated and saturated steam, the history of superheated steam from the time of Richard Trevethick is traced, an exhaustive chapter with charts and tables is devoted to the properties of superheated steam, while a chapter on the Advantage of the Use of Superheated Steam, with a discussion of causes and reasons, and illustrated by tests, leads naturally to the description of the superheater as made by the Babcock & Wilcox Co. The book is a fitting complement to "Steam," and will find as welcome a place upon the book shelves of engineers.

CHAIN GRATE STOKER. By the Babcock & Wilcox Co., 85 Liberty St., New York City. Cloth; 63 pages, 7½x10¼ in.; illustrated.

This book describes the automatic stokers of the chain-grate type manufactured by the company, with illustrations showing their application to various types of B. & W. boilers. The first chapter deals with the tendency toward increased overload, high efficiency and smokeless combustion, and points out that these results are better obtained by stoker-fired furnaces than by hand firing.

The advantages of the chain-grate stoker are enumerated, and the claim is made that it more fully meets the requirements of automatic firing than other types. Considerable space is devoted to the construction of the B. & W. chain-grate stoker, as well as to its application to various types of furnaces.

An interesting chapter deals with the furnace-fire brickwork, the quality of the bricks and what their condition should be when used in building the furnace linings and firebrick arches.

The volume is handsomely illustrated, showing installations of these chain-grate stokers to boilers with different types of furnaces, and contains tables showing the tests of boilers equipped with this stoker.

STEAM PIPES, THEIR CONSTRUCTION AND ARRANGEMENT. Published by the Vulcan Boiler & General Insurance Co., Manchester, England. Size, 8¼x5¼ in.; 108 pages. Flexible cloth. Price, 1 shilling.

This book, one of the engineering manuals put out by the above company, is chiefly for the purpose of promoting safety by practical literature on boiler subjects. Chapter one deals with steam velocity and draining of pipes. The book gives 60 ft. per second as the allowable velocity in steam pipes under 200-lb. pressure, with slightly higher velocity for lower pressures. The minimum diameter of steam pipe for an engine of good design may be obtained by multiplying the piston speed in feet per minute by the diameter in inches of the high-pressure cylinder and dividing by 1500, then taking the next larger size pipe. The velocity of steam in exhaust pipes with good vacuum may be allowed to reach 350 ft. per second.

The company does not recommend that steam pipes be laid to drain back into the boiler, but that provision should be made for draining a line at all points where water may collect. Consideration is given water separators, traps, material and construction of steam pipes, pipe and expansion joints, pipe standards, hangers and supports, exhaust-steam piping arrangement and fittings, and valves. Emergency-pipe work and insulating material are also included.

The book is excellently indexed and illustrated, and engineers and steam fitters should welcome it as a book that is truly useful.

Recent Court Decisions

Digested by A. L. H. STREET

Responsibility for Defective Engine—An employer is not liable for injury to an employee caused by automatically starting a stationary engine, due to a leaky throttle-valve, unless the employer was chargeable with negligence in permitting the engine to become or remain in a defective condition; the mere fact that such condition existed does not establish actionable negligence. (Alabama Supreme Court, Epsey vs. Cahaba Coal Co., 64 "Southern Reporter," 753.)

Risk Assumed by Electrician—An experienced electrician assumes the risk of being injured or killed through handling charged power wires with his hands, in removing them from one pole to another, if the accident be attributable to his failure to use the rubber gloves furnished him. In such circumstances, the failure of the company to shut off the current while the wires are being moved cannot be regarded as the direct cause of the accident. (North Carolina Supreme Court, Register vs. Tidewater Power Co., 81 "Southeastern Reporter," 326.)

Liability for Flooding Lands—A 3-ft. dam constructed in a creek to furnish water for generating steam in a power plant has just been held by the Indiana Appellate Court to have made the owner responsible to a proprietor of upstream lands in damages, for the consequent swelling of the waters of the creek, although the flooding was slight, the banks of the stream not being overflowed, and although the value of such lands was not depreciated. (Guynn vs. Wabash Water & Light Co., 104 "Northeastern Reporter," 849.) The court finds that nominal damages at least are recoverable. The decision is rested on the principle that the owner of riparian land is entitled to have the stream maintained in its natural condition, unless the right of flowage is acquired on payment of compensation to him.

Discrimination Between Public Service Corporations—A state law which prohibits a city council from granting permission to a public service corporation to lay pipes in a street or alley for the distribution of gas to consumers, unless the consent of a certain percentage of abutting property owners is first obtained, while water companies are left free to lay their pipes without obtaining such consent, violates the provision of the Illinois constitution. It forbids the passage of local or special laws granting exclusive privileges, according to a decision of the Illinois Supreme Court, announced in the recent case of People vs. Kewanee Light & Power Co., 104 "Northeastern Reporter," 680. Hence, the court finds that, so far as a law enacted by the Illinois legislature in 1897 discriminates in this manner, it is void. The law also discriminates against the erection of electric-light poles and wires in streets by requiring consent of owners of more than one-half of the abutting lands, whereas no such consent is required for the construction of wires and poles for the transmission of electric power.

Tank-Ship Explosion

Two explosions aboard the oil-burning tank steamship "Chenango" as she lay at South Pier, Robin's drydock, off Dwight St., Brooklyn, on June 9, set the vessel afire.

The chief engineer was rescued from the flames by the police and taken to the Holy Family Hospital severely burned.

The "Chenango," which is owned by the Gulf Refining Co., was to leave the next day for Galveston. Allan P. Garrison, chief engineer, of Philadelphia, went down to the engine room to see that all was in readiness for the start. He carried a lighted lamp, and it was said the flames from the lamp ignited the gases from the oil fuel stored in the hold.

Both hatches were blown away and the report of the explosions shook the neighborhood. Police Lieutenant McMullin and a patrolman dragged the engineer ashore. An alarm brought the fire department and the flames were got under control after a two-hours' fight.

Westinghouse Strike Situation

The spirit of optimism seems to prevail among the officers of the various Westinghouse companies in the Pittsburgh district as to the strike situation, according to the last report from the officials, and there is a feeling prevalent that in a short time there will be a general movement to return to work on the part of a majority of their men.

A number of employees of the Union Switch & Signal Co. walked out at noon on a Friday without presenting any reasons for so doing. The company promptly announced that the works would be shut down until the following Monday, at which time the employees would be expected to return. Practically the full quota of men has now returned, and this, coupled with the unsuccessful attempt of the strikers to call out the men at the Westinghouse foundries at Trafford City, has given their cause a serious setback and seems to indicate a speedy return to normal conditions.

The management states that there has not been any change in its attitude with reference to importing "strike breakers," but so far it has devoted its energies toward safeguarding the valuable properties placed in its charge.

When asked as to the effect of the strike on the business of the companies, one of the officers stated that owing to the policy adopted several months ago of manufacturing goods for stock in order to provide work for its employees during the dull period, a large amount of goods, sufficient in many lines for several months' requirements, had been made and distributed to the company's warehouses in various parts of the country, from which orders have been filled daily without delay.

Hydro-Electric Plant at Long Lake Completed

With the completion of the new hydro-electric plant at Long Lake on the Spokane River, Washington, the Washington Water Power Co. will have four hydro-electric generating stations on that river.

The plant will have four generators of about 18,000 hp. each, with a continuous overload capacity of 25 per cent.; each generator will be connected to a 22,500-hp. waterwheel, the largest yet built. When completed, the Long Lake station will be the company's largest project. It is 30 miles from Spokane. Power is furnished by a dam 200 ft. high, creating a lake 23 miles long and giving a fall of 170 ft. This dam will give storage not only for the new plant, but also for the Little Falls plant, further down the river.

The Long Lake dam is unique in that it is the highest spillway dam yet erected for a hydro-electric development, and when the river is at flood more than 19 ft. of water will pour over its crest.

Conservation Matters Before Congress

President Wilson's declaration that Congress must pass a number of conservation bills before adjournment has aroused new interest in the question of water-power development and power sites. A general water-power bill and a revision of the laws relating to the building of dams in navigable streams have been favorably reported to the House, and are among the measures on which action is demanded by the President as necessary to a fulfillment of party platform pledges.

Announcement that an investigation of the Keokuk dam and water-power development will be made during the summer by a congressional committee promises to shed additional light upon the manner in which water powers have been monopolized under the old laws, as well as upon the methods by which the monopoly controls and maintains high prices to the consumer. The charge that the Keokuk dam obstructs navigation in the Mississippi will also be investigated.

Secretary Franklin K. Lane, of the Department of Agriculture, who is a single taxer, seems to have won the President and the entire Cabinet over to the belief in government ownership of hydro-electric power and power plants. Both the general dam and the water-power bills now before the House follow closely along the lines urged by him, which provide for limited franchises of fifty years to dam and power companies, and for the purchase of the property by the government at the end of the fifty-year term.

In the case of dams built upon navigable streams, it is proposed that the Secretary of War shall have the authority to regulate rates for power sold by dam companies when sold in interstate commerce. If the government takes over the property at the end of the franchise term, it is to pay the "fair value" of all the property owned by the company and all the capital expenditures it has been in connection with its business, and is also to assume whatever unfinished contracts the dam company may have entered into.

As a measure to prevent the further monopolization of power and dam sites without use, the pending legislation proposes that actual work upon the construction of dam and power works shall be begun within one year of the time the grant is made, and completed within three years.

The general provisions of the dam bill are made to apply to companies operating under existing grants or franchises, as well as to those who may hereafter be granted franchises. If these bills become law, the effect will be to place the government in the position of being able to take over all existing dam companies and water-power plants at the end of fifty years.

Large Gate Valves for New York Edison Co.

Perhaps the largest steel gate valves for superheated steam yet installed in any of the immense power plants are those recently built by the Nelson Valve Co., Philadelphia, for the New York Edison Co., New York City.

Seven of these valves were built and shipped in 50 days from the receipt of the order. Each open valve, from the top of the stem to the bottom of the body, stands 9 ft. 1 in. in height, and the two types weigh 3600 and 3900 lb. respectively. The hand-operated design is made with a large bushing just below the handwheel, which may be removed for attachment of spur gears if desired.

The other type of valve is fitted with spur gears, and bevel gears for chain operation. This valve will be placed in a vertical pipe line and the extension stem (to which is attached a bevel gear) runs through a wall for operating from another room. The valve can also be operated by chain, the chain wheel being attached to the valve stem. These valves will be used on header lines carrying 200 lb. pressure with 150 degrees superheat.

Each valve has a steel body and bonnet, with seat and disk wings of forged monel metal and a valve stem of rolled monel. Brackets are provided on the inside of the yoke to support the gland when repacking the stem; eye-bolts, at the top of the bonnet, swing out of the way so that the valve may be repacked. The steel and monel metals have a tensile strength of over 65,000 lb. per square inch, and their coefficients of expansion are practically the same.

ENGINEERING AFFAIRS

The Association of Edison Illuminating Companies Convention will be held at White Sulphur Springs, W. Va., Sept. 14 to 17, at the Greenbrier Hotel. The active work will be confined to about twelve general papers and ten special committee reports. A fine program of entertainment and sports has been prepared for the delegates.

National Association of Corporation Schools—The second annual convention of the National Association of Corporation Schools was held in Philadelphia from June 9 to 12, at the new auditorium of the Curtis Publishing Co. A number of men connected with the electrical industry were on the program, including Arthur Williams, New York Edison Co.; C. A. S. Howlett, General Electric Co.; F. C. Henderschott, New York Edison Co.; C. P. Steinmetz, General Electric Co.; M. W. Alexander, General Electric Co.; R. J. Watson, Westinghouse Electric & Manufacturing Co.; W. M. Skiff, National Lamp Works; S. W. Ashe, General Electric Co.; C. R. Dooley, Westinghouse Electric & Manufacturing Co.; J. C. Robinson, New York Edison Co.; William H. Tolman, American Museum of Safety, and Dr. C. A. Lauffer, Westinghouse Electric & Manufacturing Co.

PERSONALS

E. F. Goad has been appointed chief engineer for the Chicago Heights Pure Ice Co., Chicago, Ill. Mr. Goad was until recently with the Lake County Ice & Cold Storage Co.

J. Russell Hormell, formerly chief engineer at the Carnegie Coal Co. plant, at Charleroi, Penn., now occupies that position at the plant of the Lilley Coal & Coke Co., West Brownsville, Penn.

Walter M. Brainerd, formerly chief engineer and superintendent of the New York Masonic Temple, West Twenty-Third St., New York City, has been appointed secretary and treasurer of the Engineering Utilities Corporation, 1161 Broadway, New York City.

E. D. Rasmussen, formerly with the Allis-Chalmers Co., Milwaukee, Wis., as erecting engineer and master mechanic for the Oshkosh Grass Matting Co., Oshkosh, Wis., the past two years, was, on June 1, appointed superintendent of machinery of the Oshkosh Steam Boat Co. in addition to his present position.

William A. Bole has been chosen by the board of directors of the Westinghouse Machine Co. to be vice-president in charge of production and erection for the plants at East Pittsburgh and at Trafford. Mr. Bole has been in the continuous employ of the company since August, 1882, having successively filled the positions of general shop foreman, superintendent, manager of works and consulting engineer, and has therefore taken part in the growth and development of the company since it employed less than one hundred men until the present, when the total forces run up into the thousands of operatives.

OBITUARY

FRANK L. BUSEY

Frank L. Busey, a valued contributor to "Power," and engineer of the Buffalo Forge Co., died on June 7 at the Battle Creek Sanitarium. His death was due to spinal meningitis.

JACOB C. SOTTER

Jacob C. Sotter, for fifty-seven years head of Sotter Bros. Boiler Works, Pottstown, Penn., an inventor and bank director, died on Saturday afternoon, June 20, after an operation ten days before for acute appendicitis. He left a fortune estimated at $1,000,000.

GEORGE W. NISTLE

The sudden death of George W. Nistle, one of the founders and vice-president of the Illinois Engineering Co., Chicago, Ill., is announced. He died on May 27, in his sixtieth year. His home was in Muskegon, Mich. Mr. Nistle was a member of the American Society of Mechanical Engineers, having joined in 1901.

CHARLES B. ELLIOTT

Charles Bradford Elliott, chief engineer of the Haverhill (Mass.) Electric Light Co., is dead at the age of 41 years. He was the son of the late Edwin G. Elliott, former superintendent of Bradford academy, who died two years ago, and Mrs. Mary B. Elliott, of Greanleaf Street, Bradford district. In addition to his mother, he also leaves a brother, George E. Elliott of 18 LeRoy Avenue, Bradford.

Mr. Elliott was one of the oldest employees of the electric company, having connection with it as chief engineer as early as the time it was located near the Boston & Maine depot under the old management.

He was a kindly, courteous gentleman, and highly regarded by the men at the plant. Mr. Elliott was a member of Merrimac Lodge, A. F. A. M., and of the Blue Room Club of Boston. He was unmarried.

CHARLES F. EIKER

Charles F. Eiker, treasurer of the Perolin Co. of America, Chicago and New York, died suddenly at Cleveland, Ohio, Saturday morning, June 6, where he had gone to fill a business engagement. When he left Chicago the evening before he was apparently in perfect health and contemplated his trip with unusual interest. It was to be a farewell greeting between himself and President Kopper, who had perfected all arrangements for sailing June 10 for a trip to Europe.

"It was indeed fitting that these two comrades," says an officer of the company, "who have labored with such unbroken harmony together in the development of Perolin products to their present standard, should have been together when the latch was lifted that welcomed one of them to eternity. Far be it from me to intrude a word of flattery on such an occasion; yet no man was more grounded in the principles of common honesty than Mr. Eiker, nor paid greater devotion to them in the practical affairs of life. No man possessed a kindlier nature, or could have been a truer friend or finer associate. There will be no change in the policies of our company and the business will continue without interruption."